MACHINERY.

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AMONG THE SHOPS.

ENLARGED PLANT OF THE BULLARD MACHINE TOOL CO.—STRIKING EXAMPLES OF JIG WORK.

During the past year the Bullard Machine Tool Co., Bridgeport, Conn., manufacturers of boring mills, turret machines and lathes, have made extensive additions to their plant. Part of these are in continuation of additions to the main machine shop made a few years ago; while a model blacksmith shop and boiler house have been built and a new power plant installed, with a generator for electric driving and lighting. The total floor space added this year amounts to about 32,000 square feet.

This company was established in 1880 as the Bridgeport Machine Tool Works, E. P. Bullard, proprietor, and was incorporated in its present name in 1894. It was originally quartered in a four-story, brick building, which forms part of the present works; but aside from this building the structures are of the most modern type of brick and steel construction. An interior view of the central span of the main shop appears on this page. This building is 275 feet long, 40 feet wide in the center, with wings on each side 175 by 40 feet, arranged with galleries of the same floor space, after the usual custom for such buildings. The central span is served by two ten-ton electric cranes.

Fig. 1. Central Span of Main Shop. This Section is 40 feet Wide by 275 feet Long, is Served by two 10-ton Cranes and has a Concrete Floor.

A Few Interesting Features.

The ground floor of the main building is of concrete throughout, consisting of 4″ of rubble laid directly on the ground and 2″ of Portland cement, broken stone and sand for the top. The heavy tools are set on this floor without other foundation and it is found to make a satisfactory setting. The shop is lighted by windows in the roof, of corrugated glass, and by windows at the side. The attention paid to the matter of light is strikingly apparent. The galleries not only have the benefit of the side windows, but of those overhead also; and the shop walls are white inside and outside as well, wherever there are two walls of adjacent buildings coming near to one another tending to shut out the light. It is found that the reflection from these white walls increases the light within the buildings very appreciably.

In the general view of the main floor in Fig. 1, it will be noticed that there is a line shaft just under the girders supporting one of the tracks for the traveling cranes. As this floor is used for erecting boring mills it is necessary to have some convenient method for driving the mills when facing the tables, and also for driving the bars used for boring the vertical bearings for the table spindles. As the mills may have to set at almost any point on the floor, and be started and stopped independently of the others under process of erection, it is desirable to be able

to drive them independently, wherever they happen to set. To accomplish this, and also to give a number of different driving speeds, the line shaft referred to is fitted with a number of loose cone pulleys at intervals of a few feet, which are driven through friction clutches. A belt can thus be easily run to a machine in almost any position, any speed within the limits of the cone pulley can be obtained, and any machine can be started or stopped by operating the clutch through which it is driven.

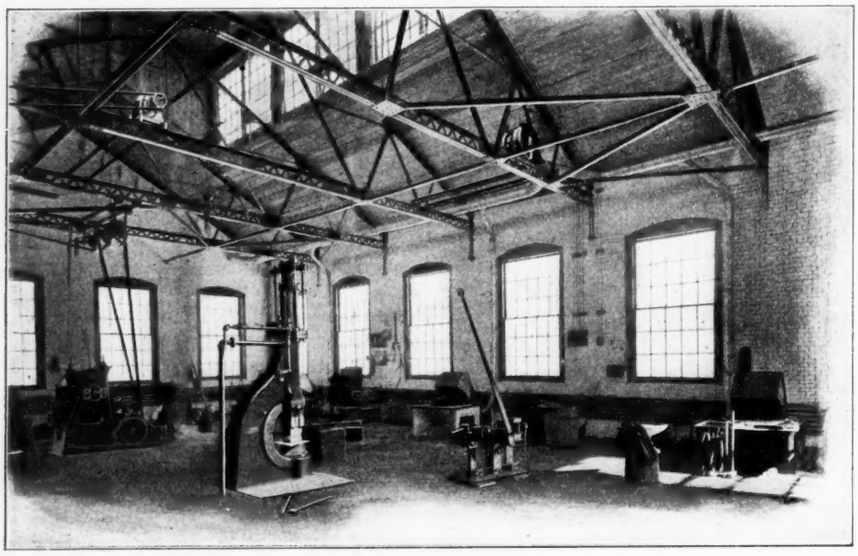

Fig. 2. New Model Blacksmith Shop at the Bullard Co.'s Works.

To further facilitate assembling and erecting, a number of long pits about four feet wide and three feet deep have been dug in the erecting floor and walled up, thus enabling a man to work underneath a machine easily. This is an important matter in building tools of the character of boring mills. To cover the pits when not in use, short lengths of rolled T-beams are employed, the side walls of the pits being capped with castings of a shape suitable to receive the ends of the beams, as indicated in the sketch in Fig. 6, page 259.

In the illustration in Fig. 3 one of these pits is shown with the covering beams in place. This illustration also shows a group of boring mills made by this company.

Many offices have storm doors and possibly an occasional machine shop may be fitted with them; but we doubt whether many concerns have equipped their works with so extensive a storm door as is placed at one end of the main floor of this shop. The building is heated by the Sturtevant hot-air system and is thoroughly warm in cold weather; but it faces the north, and when the large doors at the end were opened to allow trucks to be driven in, so cold a blast of air always accompanied the truck that it cooled off the whole building to the discomfiture of all. An immense vestibule, or air lock, was therefore built inside of this end of the shop to enclose the door, into which a team can be driven when entering. The outside doors are then closed and the inner ones opened and the team can enter the shop without letting in more cold air than is contained in the air lock.

Shop Fittings.

Several of the shop fittings in use here are shown in the group of sketches on page 259. The shop benches throughout the works have cast-iron supports or legs made from patterns designed by this company, which are of neat design. As shown in Fig. 9, the completed bench has drawers and a shelf underneath for storage. The most novel feature about the construction is the arrangement of the planks for the top. Instead of running lengthwise of the bench, they run crosswise, and so one or more short lengths can be renewed at any particular spot, if worn, without having to replace a large plank. This design is not claimed as original, but embodies features obtained from several sources.

In Fig. 5 is an end view of the scrapers' and fitters' bench that has been found useful, inasmuch as it gives access to the work from underneath. Scattered throughout the shop at the different machines are tool racks which were also built here and do as much as any one thing to preserve an orderly appearance in the shop. They serve as receptacles for tools, castings, finished work, etc. One of these is represented in Fig. 4. The castings for the shelves, a, b and c, are simply hollow, square frames, pinned to the uprights and with wooden shelving. In Figs. 7 and 8 are two styles of racks for storing, in the one case finished work and in the other rough stock. There is nothing particularly new about these racks, but it will be noted that the upper bracket has a wooden strip to prevent marring finished work and that the arms of the rack in Fig. 8 slope upward so that the weight of the heaviest part of the stock will be supported next to the upright.

As before intimated, the shops are lighted by electricity and a large number of lamp brackets made by the O. C. White Co., Worcester, Mass., are in use. These are intended to support single incandescent lamps, the lamp being held by a long, slender arm, which swivels in any direction from its point of support and can be clamped in position. It was originally intended that these brackets be supported from the walls or the ceiling, but a number of them have been attached to cast-iron standards which set on the floor and can be moved about the shop. This convenient arrangement enables the workman to bring the light into just the position best adapted to his requirements.

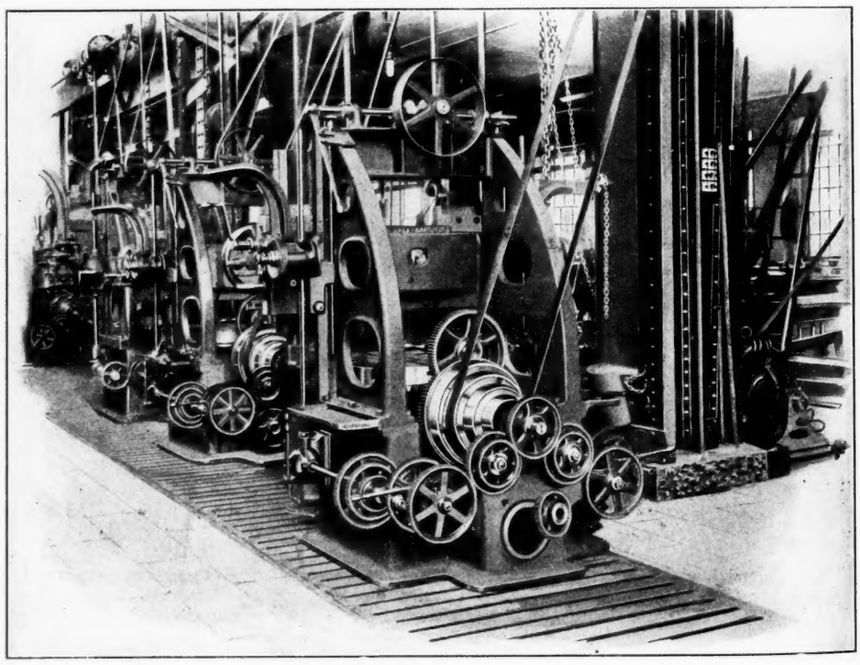

Fig. 3. Group of Boring Mills, Showing also One of the Covered Pits on the Erecting Floor.

Blacksmith Shop.

In Fig. 2 is an interior view of the new blacksmith shop, which is about as modern and attractive in its appointments as it is

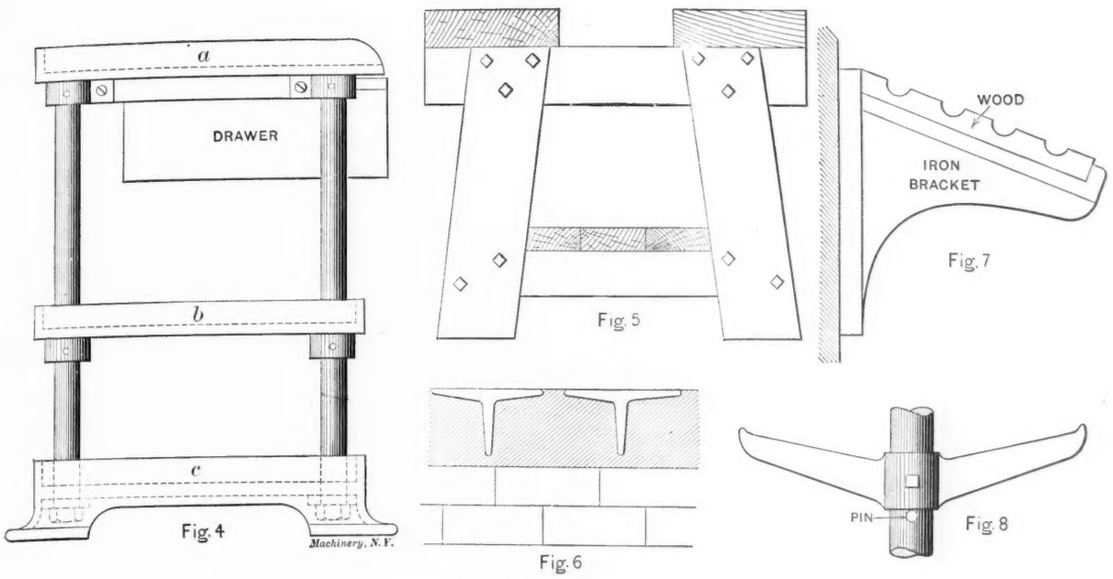

Fig. 4 Fig. 5 Fig. 6 Fig. 7 Fig. 8

Group of Shop Fixtures.

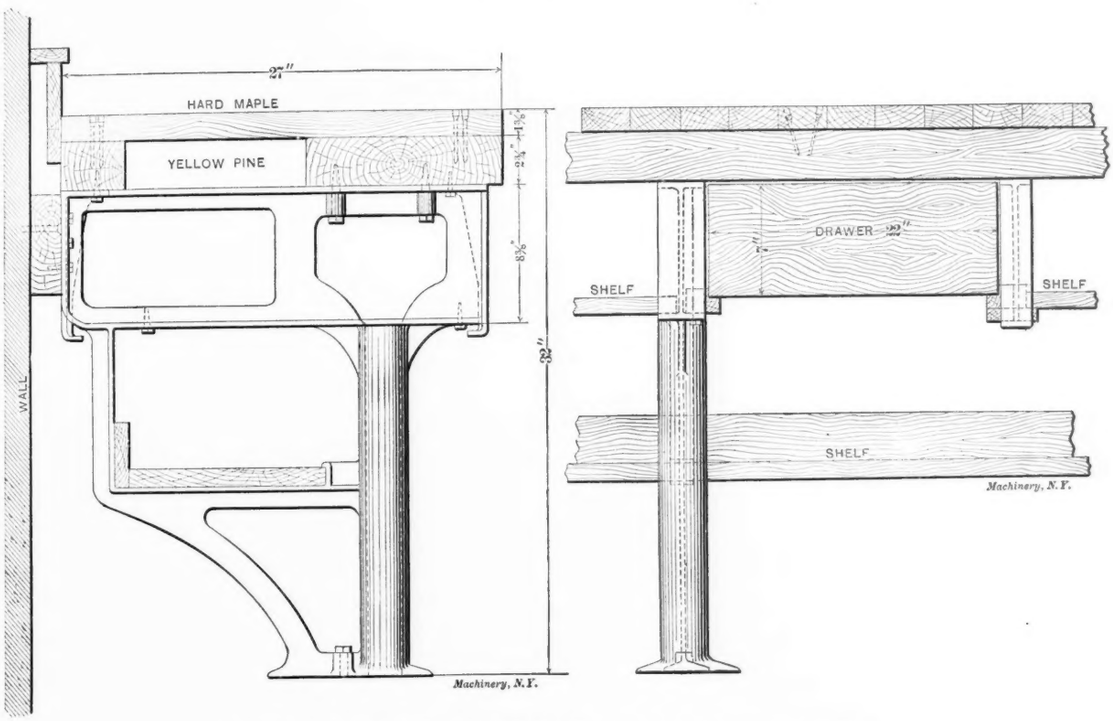

Fig. 9. End and Front Views of Work Benches Used at the Bullard Co.'s Works.

possible for a blacksmith shop to be. There are a steam and power hammer and three down-draft forges, besides an ingot forge and the necessary tools. The blast is from an electrically-driven fan and the method of conducting the smoke and gases from the forges is decidedly novel. A chimney had to be built for the new power plant and the idea was suggested and carried out of running a duct from the forges to the space between the outer and inner walls of the chimney, thus allowing the forge gases to escape up the chimney and obtain to a certain extent the advantage of the draft gained from the heat of boiler gases passing up the inner flue, without endangering the boiler draft by connecting the forges directly to the inner flue. The chimney is of brick, 100 feet high, the inner flue is 54 inches in diameter, and the air space of sufficient capacity to carry off the gases from the duct leading from the three forges, which is 24 by 30 inches in cross-section. This arrangement works very satisfactorily, and as far as we know, is new.

Like the other buildings, the blacksmith shop has white walls inside and they were not only painted white at the start, but they are kept white by repeated applications of whitewash. The room is also well ventilated, high studded, has tight lockers for clothing, and sanitary closets.

General Methods.

It requires but a brief inspection to make it plain that the use of jigs and gages for producing standard work is carried on to an extent in this plant that is seldom seen in machine tool shops. Jigs are not only used for the smaller pieces, but for much of the large work. Their 30-inch boring mills are built throughout by the aid of jigs and, as they are put through in large lots, their production is practically on a manufacturing basis, which experience shows not only makes the very desirable quality of interchangeability a requisite, but actually produces more uniformly accurate work. Through the courtesy of the management we are permitted to illustrate several examples of jig work which we think our readers will find well worthy their attention.

Expanding reamers are used extensively and the means at hand for keeping holes standard is clearly indicated in Fig. 13. This shows a case of standard gages and reamers that are of considerable interest. The gages range from ½ inch to 3 inches in diameter, varying by sixteenths, and are of the design shown in

the sketch in Fig. 10. The central part is knurled, one end is standard and the other end is ground in two sections, one for maximum and the other for minimum limits. A practice is followed which we think could be more generally adopted to advantage and that is of cutting spiral oil runs on the spindles and shafts of the machines, with simply a straight groove across the bottom of the box. The grooves of the shaft revolve with the

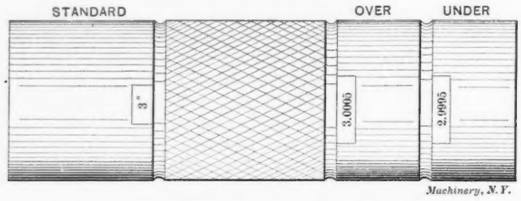

Fig. 10. Combined Standard and Limit Plug Gage.

latter and carry the oil better than the stationary grooves of the box, and, moreover, are not as likely to clog.

The Use of Jigs.

A fixture for a horizontal boring mill is in use which, while simple and probably not new to most shops, is well worthy of attention. A bracket B in Fig. 11 is to have holes bored at a and b which must be located in certain definite positions. The base of B is made with a tongue which fits one of the T-slots in the boring machine table and also a corresponding groove in the frame of the machine of which it forms a part. The fixture consists of the two uprights, A and C, with their bushings, which serve as guides for the boring bar. These uprights are tongued to fit the T-slot of the table, and thus can be correctly located at once with the bracket B. Instead of having to lay out the holes in the bracket and set the bar as nearly as may be by trial, the holes can be easily bored without laying out by using the bearings in the uprights for the bar.

This plan of using tongues and grooves for locating parts of machinery on the machine frame or for setting a jig in the right relative position with the piece upon which work is to be done, is susceptible of extended application. The principle is useful in planer work where a gage for setting the tool may be set by one

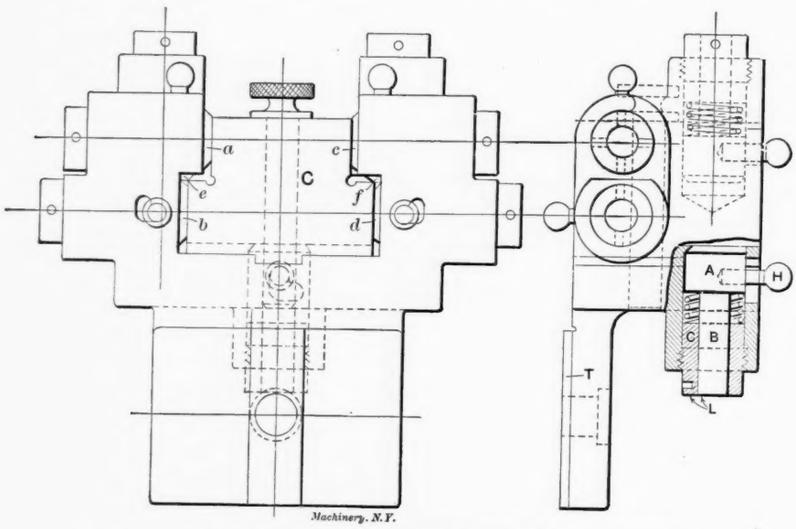

Fig. 12. Adjustable Planer Gage for Planing T-slots in Boring Mill Tables.

of the T-slots in the planer table, and the work located by the same slot and at the Bullard works many pieces are planed in this way.

An interesting gage of this description is illustrated in Fig. 12. It is designed for setting the planer tool when planing the T-slots in the tables of boring mills. These slots are sometimes used for holding chuck jaws and must be accurately finished to size. The table is first turned and a hole bored at its center. It is then placed on the planer table, the hole fitting on a spindle or post which has a tongued base fitting one of the slots in the table. The gage is bolted to a knee, which has a vertical groove fitting the tongue T of the gage and also a tongue fitting the planer slot. G is a test gage of the exact form of the slot to be planed and it is used for adjusting six hardened pins, a, b, c, d, e and f, of the planer gage. A section of one of these pins appears in the right-hand view. It consists of a head A, and a smaller neck or spindle B, which is free to slide in a bushing C. The coiled spring always tends to force the pin inward and in adjusting the pin its face is allowed to bear against one face of the gage G. The bushing C is then screwed out or in until its outer end is even or flush with the end of the spindle B at L, as determined by the sense of feeling with the finger tip. Having thus adjusted all the pins, the process of setting the planer tool to any one of them is simply to bring the tool against the face of

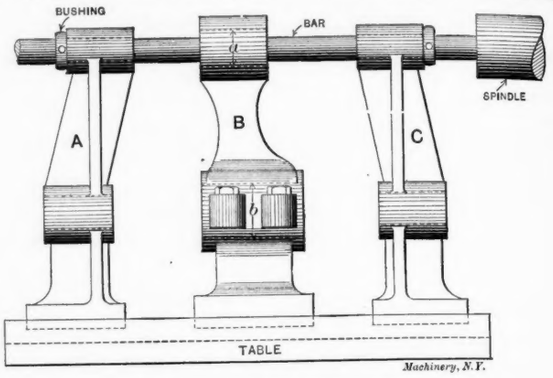

Fig. 11. Simple Boring Machine Fixture.

the pin and move the tool until the ends of the pin spindle and the bushing are even. To avoid injury to the pins, by the tool over-running when the planer is in operation, there is a handle H which serves to move the pin back out of the way and by turning slightly the handle will catch in a slot and retain the pin.

There are two more examples of jig work that we will refer to, one of which is illustrated in Fig. 14. This represents a drill-press fixture for boring, facing and reaming the bearings in a casting that contains the feedworks for one spindle of a boring mill. There are two sets of three holes each, which must be bored and reamed in line, with the two lines of holes parallel and a definite distance apart. The photograph shows the fixture, with the casting in place and with two bars in position, on each of which is a set of shell reamers.

The other example is of the same character, but is more elaborate. There are more operations to be performed upon the piece, and the fixture together with the bars, cutters, reamers, etc., make as elaborate a set of tools as will often be found for work of this size and character.

To fully understand the operations to be performed in this fixture, reference must be made to the castings on the truck in Fig. 15. This illustration represents a top and bottom view of a casting for the driving mechanism of a boring mill. The surfaces A A of the flange are first planed, these being the surfaces upon which the casting rests when in place on the mill. All the other operations are performed in the fixture in Fig. 16, the casting being supported in the fixture by the planed surfaces of this flange. There are seven holes to be drilled in the flange, which must also be either countersunk or spot faced. There are four bearings to be bored, reamed and faced on their ends, the two larger ones being in the hubs B and C and the two smaller ones just above them in the photograph. The hub C, besides being faced, must be turned on the outside to receive a trunnion that fits upon it.

Referring to the tools in Fig. 16 it will be seen that seven bars are required for boring, facing and reaming, one of the boring bars being in position. At the left is a pile of inserted-tooth facing cutters, of which one is in the foreground at A. This view of the cutter shows that there are four inserted teeth at different distances from the center, so that the full width of the hub to be faced will be covered. These cutters are employed for roughing

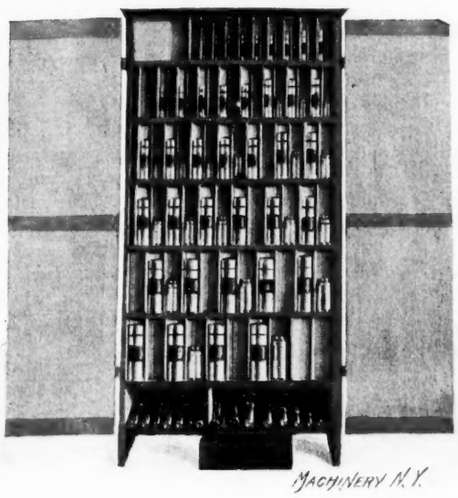

Fig. 13. Cupboard of Gages and Standard Reamers from 1-2 inch to 3 inches.

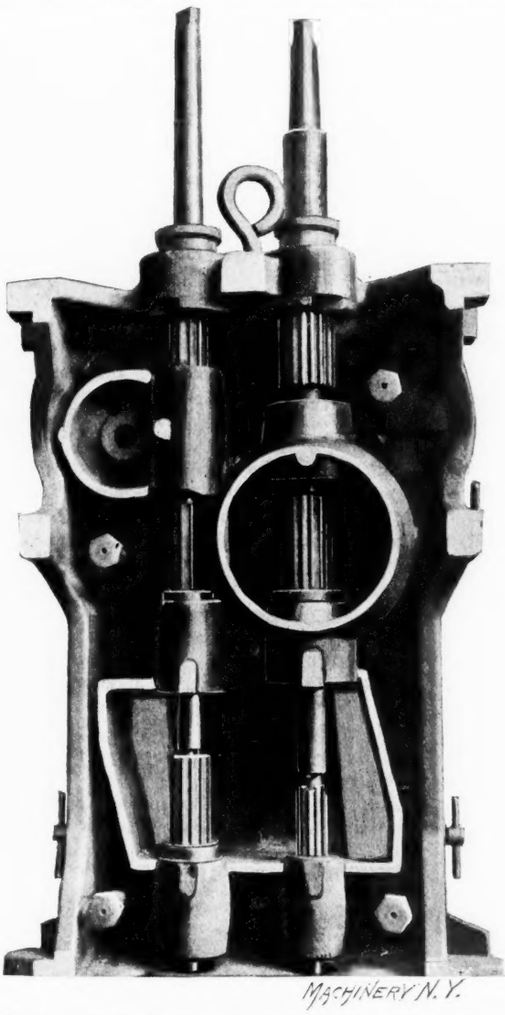

Fig. 14. Fixture for Boring and Reaming Feed-works Casting.

out, and on top of the fixture is a set of cutters used for finishing. At B is one of the cutter bars used for facing and it is threaded at its upper end for the stop C, which gages the depth to which the facing tool can operate, and which can have any adjustment desired by turning one way or the other. At D are the two cutters and holders used for turning the outside of the hub C, in Fig. 15.

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SPRING MEETING, A. S. M. E.

The spring meeting of the American Society for Mechanical Engineers will be held from May 15th to 18th. The following papers will be presented at the different sessions:

Wednesday morning, May 16th: "On the Value of a Horse Power," by Geo. I. Rockwood; "Hot Water Heating from a Central Station," by H. T. Yaryan; "Systems of Efficiency of Electric Transmission in Factories and Mills," by W. S. Aldrich; "Design of Speed Cones," by J. J. Guest.

Wednesday evening: "Multiple Cylinder Engines," by Robt. H. Thurston; "The Gas Engine Hot-tube as an Ignition Timing Device," by Wm. T. McGruder; "Water Softening Plant of the Lorain Steel Co.," by N. O. Goldsmith; "Education of Machinists, Foremen and Engineers," by M. P. Higgins.

Thursday morning, May 17th: "The Automobile Wagon for Heavy Duty," by Arthur Herschmann; "A Test of a Fifteen Million High Duty Pumping Engine at Grand Rapids, Mich.," by M. E. Cooley; "Tests of the Snow Pumping Engine at the Riverside Station of the Indianapolis Water Company," by W. F. M. Goss; "Cylinder Proportions for Compound and Triple Expansion Engines," by B. C. Ball.

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Fig. 15. Views of a Casting for which the Fixture in Fig. 16 is Used.

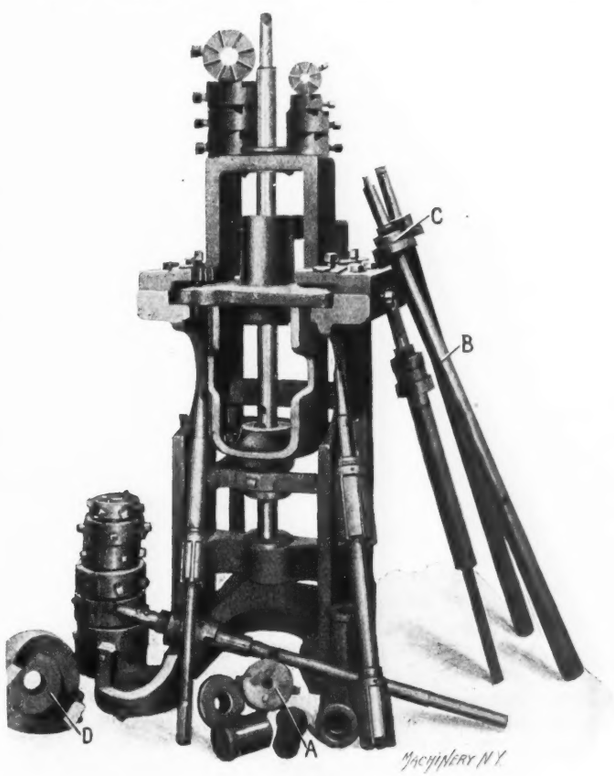


Fig. 16. Fixture for Boring, Facing, Turning and Reaming a Casting containing the Driving Mechanism for a Boring Mill.

EPICYCLIC GEARING.—2.

APPLICATIONS IN SPUR GEARING.

Those who were subscribers to MACHINERY last August will remember an article that was published in that number treating of the principles of epicyclic gearing and giving directions for calculating the forms of such gearing that most often occur. In this and a subsequent number we shall illustrate a few applications of epicyclic gearing to actual practice, showing a number of cases where it contributes largely to the success of the machines upon which it is used.

The writer has questioned the recent graduates of a number of colleges of engineering as to the instruction given in this subject, and from their apparent unfamiliarity with it, it would seem that epicyclic gearing were not receiving the attention that it deserves. Certain recent text-books upon mechanism contain little or nothing upon it. Kent's pocket book does little more than to define epicyclic gearing, and there seems to be a general lack of material and instruction concerning this branch of mechanism, that is quite disproportionate to its importance. This is doubly true in view of the comparatively large amount of attention paid to some of the less necessary branches of mechanism, like parallel motions, for example, which are practically obsolete, except in indicator practice.

Epicyclic spur gearing has been used in several forms, beginning with the time when James Watt employed the sun and planet wheels to take the place of the simple crank motion. It

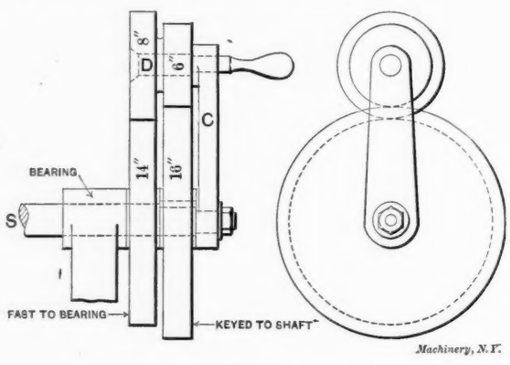


Fig. 1.

is now used for back gearing on machine tools, for hoists, for drill-press feeds, for boring-bar feeds, for driving the type beds of printing presses as well as for controlling certain motions on these presses; and it is used extensively in rope and cable laying or winding machinery. There are many places where this form of gearing could be used successfully, as for example, in securing velocity ratios difficult to secure by ordinary trains. Thus, with a reverted train of four gears with 51, 50, 49 and 50 teeth respectively, a ratio of 1 to 2,500 is secured.

The epicyclic bevel-gear is even more useful than the spur-gear train. One of its earliest applications was to cotton spinning machinery, where it marked an important advance in this class of machinery. It is still used extensively in textile machinery, and has also been applied to water-wheel and steam-engine governors, to dynamometers for the measurement of power, to motor carriages, tricycles and shafting as an equalizing mechanism, and to electric cranes for the same purpose.

In what follows no attempt will be made to refer to more than a few of the different arrangements and uses of epicyclic gearing and devices will be mentioned from among those that have actually come under the writer's observation.

About 15 years ago Mr. Chas. E. Barrett, an ingenious mechanic in Vermont, was engaged in building paper machinery, and among the novel devices that he applied was a crank motion, similar in principle to that shown in Fig. 1. The motion was used for turning a reel on which rolls of paper were supported as the paper was delivered from the machine. The usual custom was to turn the reel when it was desired to change from one roll to another, through a pinion and large spur gear, which gave enough reduction so that the reel could be easily turned by hand.

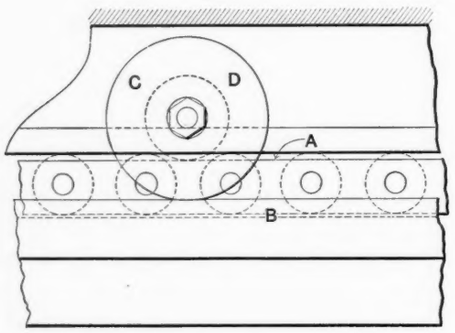
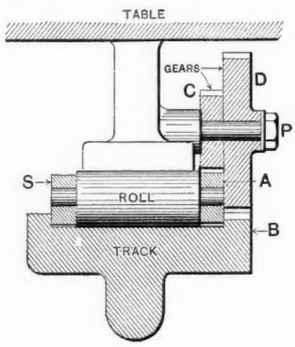


Fig. 2.



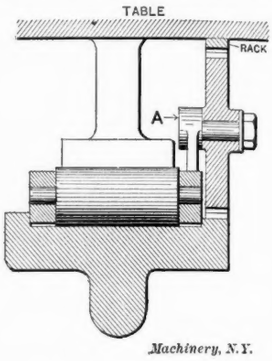


Fig. 3.

In the device shown in Fig. 1 the crank C is loose on the shaft S, but the latter is keyed to the reel. The 6 and 8-inch pinions are fast together and turn freely upon pin D, which is attached to the crank C. The 14-inch gear is fast to the bearing and does not turn, while the 16-inch gear is keyed to the shaft. When the crank is turned the pinions not only turn on their pin D, but revolve about the 14- and 16-inch gears. If the gears were all locked together and were free to turn about the shaft with the crank, the shaft would turn once for one turn of the crank; but having performed this operation, we have turned the 14-inch gear, when in reality it is stationary. Hence, the final motion will be as though the arm were held stationary and this gear were turned back once, which will cause the 16-inch gear and the shaft to turn $\frac{8}{8\frac{1}{2}}$ times. This deducted from the one turn when all wheels went with the arm gives $\frac{1}{8\frac{1}{2}}$ turn as the final result.

If, in Fig. 1, the diameters of the 14- and 16-inch gears be so increased that their radii are infinite and they become racks, while the pinions attached to the crank have a motion of translation instead of revolving about the shaft S, a mechanism will result similar to that shown in Fig. 2. This device has been applied to printing presses for controlling the motion of the frame carrying the rollers upon which the type table travels. The type table of a flat-bed press reciprocates and instead of sliding in V's like those of a planer, is made to run on rollers, to reduce the friction. These rollers are kept equidistant by a frame, and it is clear that rollers and frame should move back and forth just half as far as the table moves. To compel them to do this, and to prevent the rollers working backward or forward so far as to strike the ends of the track, a rack is attached to the track at B

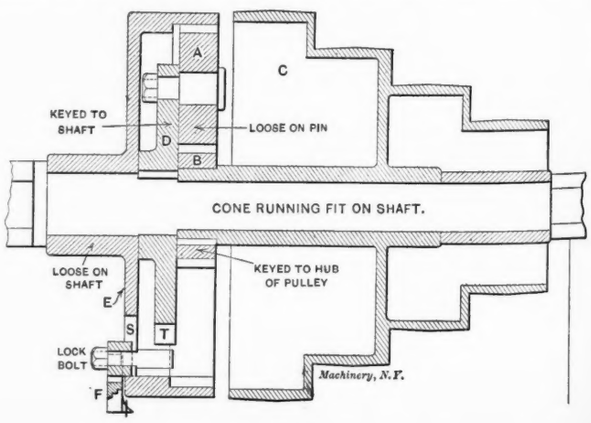


Fig. 4.

and another to the frame at A, into which the pinions D and C mesh, respectively. These pinions are fast to each other and travel with the table, and at the same time turning upon the pin P. As D is just twice the size of C, it is clear that the rollers will be driven just half as far and half as fast as the table moves.

A simpler arrangement for producing the same result is shown in Fig. 3, where only one gear is used, but it travels with the rollers instead of with the table, and runs in racks on the table and on the track.

There are several arrangements for back gears whereby all the gearing is encased within the cone. Some of these are epicyclic in their action and some are not, but in Fig. 4 is a sectional view of an epicyclic back gear that has been applied by the Betts Machine Co. to their radial drills. The cone, C, runs loose on the

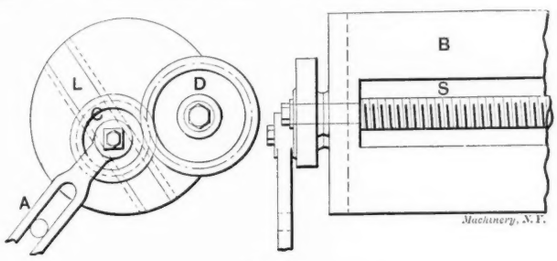


Fig. 5.

shaft, the lock-plate is keyed to the shaft, carries a pin on which the pinion A turns and has a slot at T. Pinion A meshes in a pinion B keyed to the hub of the cone pulley and also meshes with internal teeth cut on the inner periphery of the plate E. This plate is loose on the shaft and has a slot at S, in which slides the lock bolt. It will be observed that the lock bolt extends through plate E, so that when it is slid in the slot S toward the shaft it will engage in the slot T of the lock-plate D. In this position the whole system is locked together so that the cone turns the shaft. If the lock bolt be lowered, or moved away from the shaft so that its washer fits in the slot of a projection of the frame F of the machine, plate E will be kept from turning and will act as a fixed internal gear for pinion A. As cone C turns, it will drive pinion A through pinion B, and D will turn, together with the shaft, at a slower speed than the cone.

In Fig. 5 is an application of Watt's sun and planet wheel, although for quite a different purpose than that for which James Watt originated the device. The application shown is for a boring bar feed, where the bar is supported in bearings and the cutter head is fed along the bar, as the latter revolves, by a feed screw and gearing. In the sketch B is the bar, S the feed screw, and C and D the two gears that give motion to the feed screw.

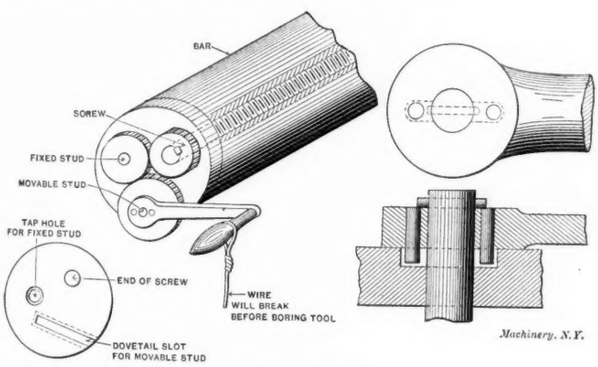


Fig. 6.

Gear D is attached to the end of the feed screw and C, which meshes with D, is prevented from turning, as the bar rotates, by the slotted link or crank A, which slides upon a stationary pin. In the end of the bar is a dove-tailed slot, L, for adjustment of the pin on which C turns, so that gears of any size can be used.

Suppose the pitch of the feed screw to be ¼ inch, right-hand thread; the number of teeth in D 30, and in C 20. What will be the feed of the cutter head for one right-hand turn of the bar? First assume that wheel C is free to turn with the bar; then for one turn of the bar both C and D will each make one right-hand turn, not upon their own axis, but about the center of the bar. We have done with C, however, what was not desired, viz., given it one turn, and hence must now move it back one turn, the bar being stationary. Wheel D and the screw, therefore, will be moved ahead 2-3 of a turn during this operation, which, added to the one turn previously made makes 1 2-3 turns for the screw, to one turn of the bar. The cutter head would thus be fed 1 2-3 × ¼ inches were it not for the fact that the nut in the head, which fits the feed screw, also makes one right-hand turn for each turn of the bar. The actual feed, therefore, is only 2-3 × ¼ = 1-6 of an inch, and the feed is toward the left in the sketch. To reverse the feed it is simply necessary to introduce an idler gear.

In Fig. 6 are details of a boring bar feed upon this principle in use at the Builders' Iron Foundry, Providence, R. I. The lettering upon the sketch will make the construction quite clear. There is an idler gear to give feed in the opposite direction from Fig. 5. The wire attached to the crank keeps the lower gear from turning and the slot for the movable stud in the end of the bar permits the use of change gears. At the right are details of the crank.

In the February, 1900, number of the paper was shown a novel drill-press feed through epicyclic gearing that the writer found in a New Hampshire shop and which may be of interest to refer to in connection with the examples just cited. With these few and simple illustrations we will drop the subject of epicyclic spur gearing, leaving epicyclic bevel gearing until another time.

* * *

THE FUTURE OF THE IRON FOUNDRY.

In a lecture delivered before the students of engineering at the Cornell University, Mr. William Kent reviewed the main features of the manufacture of iron and steel at the present day and at the close touched upon the future of this industry. He said it would seem as though the art of the engineer or inventor could go but little further in improving the methods of manufacture of steel, from the mining and transportation of the ore to the delivery of the finished product in shapes as fine as wire or nails. Everything seems to be so well done by machinery now that there is but little margin left for further saving.

The case is altogether different, however, in the manufacture of castings from cast iron. The method commonly used, that of the cupola furnace, is that of two or three centuries ago. As the 700 blast furnaces in the United States in 1873 have been replaced entirely by half as many, each one making on an average 12 times as much iron, so the thousand or more cupolas should be replaced by something better. Its use is to take good pig iron, and at great expense of labor, fuel, and waste of iron, put sulphur into the iron and deteriorate its quality.

Some day some enterprising capitalist will build a million dollar foundry alongside of a pair of blast furnaces. He will have no cupola, but he will get one grade or quality of iron from one of his blast furnaces and another grade from another, at will. A third grade he will get as desired from a Jones mixer, a two hundred ton brick-lined vessel, heated by gas on the Siemens system. Still other grades he will get, if desired, in gas heated ladles, where the metal may be treated chemically, and any grade needed for special purposes, such as car wheels or chilled rolls, he will get from a reverberatory Siemens furnace. There will be no pig iron about the place, except such as is made to be sold, or is used to change the grade in the mixer or in the reverberatory. As far as possible the metal will be used hot from the blast furnace. There will be an immense pattern storehouse, built in detached parts, where patterns will be stored from all over the country, and the foundry will have also its own patterns of standard articles, such as engine bed plates and cylinders, foundation plates, columns, etc. When such a foundry is in operation it will wipe out of existence fifty or a hundred of the small cupolas which are cumbering the ground, and a revolution will take place in the foundry industry similar to the one that began in the blast furnace industry in 1870. Here is the work for the coming generation of mechanical engineers, to put the foundry on the same grade scientifically and economically, as the blast furnace now is. All that is needed now to start this improvement is the willing capitalist, or perhaps the promoter, who knows how to show the capitalist "there's millions in it," and I do not think this greatly needed improvement in the iron industry can be much longer delayed.

ITEMS OF MECHANICAL INTEREST.

GLEANED FROM VARIOUS SOURCES.

An interesting feature of the General Electric Works at Schenectady for the bicyclist, is the immense storage sheds for the accommodation of the employees who ride to the works on their wheels. The sheds have storage room for 1,500 bicycles and for a small sum per week the wheels are kept in running repair, well cleaned and lubricated. It is unnecessary to say that the idea is a popular one with the employees, as the pleasure of having their wheels always clean and in good running condition is well worth the required expenditure.

A correspondent to a contemporary gives a recipe for cleaning rusted tools which may be valuable, but we cannot vouch for its efficacy.

If the rust be heavy, stand the tools in coal oil for a few hours, but if only slightly rusted this is not necessary. Next dip the articles in liquor potassa for a few moments and then put them into a strong solution of potassium cyanide. Remove from the solution; clean with a paste of the cyanide, castile soap, chalk and water; rinse and place in a saturated solution of chloride of tin and leave over night.

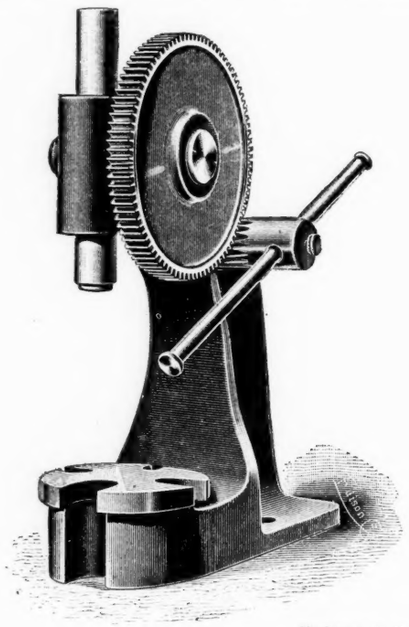
The Paris Exposition opened on April 14th, with impressive ceremonials. President Loubet formally inaugurated the Exposition, but it will be some time before it becomes an exposition in fact as well as in name. Many of the buildings have not yet been completed, and many of the exhibits are yet to be placed in position. The American exhibits are comparatively well forward. The exhibit of machinery for this country has suffered, of course, because of the loss of the machinery that was being transported on the vessel Pauillac, but every effort has been made to get the remainder, which constitutes by far the larger portion, unpacked and in place even though it is not in working order. In the next month's issue we hope to be able to report further advance and possibly give some definite information about the general character of the display.

What appears to be an absurdity in the development of the automobile, is reported as being experimented with in France. A trolley line has been constructed in the suburbs of Paris which consists of two wires so arranged that a small trolley car can be carried on them, the two wires forming a track. This arrangement is expected to furnish power to automobiles, each of which will be provided with a flexible connection to its individual trolley. To clear obstructions and other vehicles, the automobile will carry a vertical pole to the upper end of which will be attached the trolley connection. The idea then simmers down to a street car line in which the cars run on the ground instead of steel rails. While the line proposed may be a success under certain local conditions, it would appear that if there is no better solution of the power problem for the automobile than this, its development might as well be abandoned.

A stop-valve or cock in a steam gage pipe is often quite a convenience but is likely to be a dangerous trap and should never be allowed. An instance is known where a disastrous explosion was narrowly averted by the prompt action of a machinist in a railway shop, the cause being a stop cock located as mentioned. A locomotive was being fired up for the preparatory work necessary before going on the road. The safety-valves had been overhauled and were in consequence not set to any particular pressure, the springs being set to a tension that was sufficient to restrain a pressure of perhaps 100 pounds. The attendant who was fitting up the engine complained that he could not get any steam pressure after having a heavy fire going for an hour or so, the steam gage only indicating about 40 pounds pressure. A machinist who looked after the valves and gages took in the situation at a glance and turned the stop cock in the gage pipe when the pointer instantly flew around to 240 pounds and struck the stop pin with a peculiar "ping." The fires were hauled as quickly as possible and the springs on the safety valves cautiously loosened until some of the enormous excess pressure was reduced. After the boiler had cooled down an examination showed that apparently no damage had been done but the lesson was sufficient for one man at least to last him through life.

AN ENGLISH ARBOR PRESS.

It is quite evidently shown by the accompanying cut reproduced from an English contemporary, that the Britons appreciate the merits of the arbor press as one of their enterprising manufacturers is now making it in this form. The description states that "it is a mandrel press designed to supersede the



Machinery, N. Y.

method of forcing in mandrels by hammering. Its use insures good work by keeping the mandrels in good condition, and is a most useful labor-saving tool."

If the press, as made, be copied from the one that has become so popular in this country, we do not think that the British manufacturers have improved it, either in appearance or utility. It will be noticed that the press not only has no quick return, but the operating lever offers a varying turning moment to the operator, much to his disadvantage.

* * *

OBITUARY NOTES.

Waterman C. Bradley, member of the Bradley Co., manufacturers of the Bradley hammer, Syracuse, N. Y., died on March 31st at the age of 68.

Andrew D. Cramp, son of William Cramp and formerly superintendent of the Cramp shipyards, died March 29th, in Boston, aged 43 years.

William S. Doig, the inventor of box-nailing machinery, died on March 20th, aged 52. Mr. Doig was at one time connected with the firm of Smith & Doig, who manufactured various styles of machines, but later, when he became sole proprietor, he devoted himself almost exclusively to the manufacture of box-nailing machinery.

Stephen Tasker, a son of Thomas T. Tasker, of the firm of Morris & Tasker, Newcastle, Del., died in Philadelphia on March 19th, aged 65 years.

J. R. Stewart, president of the Bradford Machine Tool Co., Cincinnati, O., died in Riverside, Cal., on March 31st. He was born in Westmoreland County, Pa. He held the office of first lieutenant and afterwards captain of the 17th Regiment, Indiana Artillery, during the Rebellion. In 1870 he moved to Cincinnati, and connected himself with James Bradford, founder of the present company. He was president of the Bradford Mill Co. from 1885 to 1900, when the name was changed to the Bradford Machine Tool Co., at which time he was made president of the new corporation, which office he held until his death.

Mr. Stewart was prominent in all business circles in Cincinnati, was a mason and member of the Loyal Legion of Ohio. His wife, son and two daughters survive him.

Austin W. Goodell, of the firm of Goodell & Waters, engaged in the foundry and wood-working machinery business in Philadelphia, died on April 15th, aged 68.

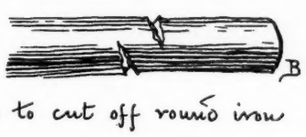
THE EVOLUTION OF ARCHIMEDES.—2.

A TRUE BIOGRAPHY.

JUNIUS.

There was one machine in Bang & Ammer's shop which Archimedes will remember until his dying day—a horizontal traverse drill on a rather low bed, so that the spindle was only about two feet from the floor, used for drilling heavy work. Once upon a time our friend had the belt upon the biggest step of the cone and a big flat drill slowly revolving with the spindle. He found that the work was not quite high enough, and carelessly leaned over the machine to pick up a wedge from behind. He felt something suddenly grab the loose front of his blouse and begin to pull. Harder and stronger pulled the big drill, and tighter and tighter drew the girdle around his waist. He tried

Fig. 1.



T. Aper Reamer, Esq.

Fig. 2.

to cry out to a shopmate at work near by, but he could not make a sound. Things began to look black, when, with a last despairing effort, he thrust the big wedge under the belt and threw it from the pulley. They unwound him by turning the drill backwards. Did you ever see the long, flowing beard of a machinist catch on a rough piece of steel which he was turning in the lathe? No? Well, let us hope you never will. Speaking of this same traverse drill—it had a long belt, running from the cone pulley up to the counter overhead, in a slanting direction. It used to be a favorite amusement with the boys to put the belt on the slowest speed and then catching hold with both hands, to let the belt pull them up from the floor a few feet, when they would let go and drop. It was a dangerous experiment, for it takes a deal of will power to make you let go in such a case, and the higher up you get, the more you hate to drop. Once Archimedes got his fingers almost under the belt on the upper pulley before he realized the danger. He dropped about six feet and struck on the floor with a shock which seemed to drive his backbone right up through his crown. But he thinks, what if he had not let go? There was no tool-room in the shop. An inclined shelf over the bench at the north side of the room, carried an assortment of flat reamers made by one of the proprietors at some remote period. Under the same bench, on a shelf and on the floor, was a miscellaneous collection of arbors or mandrels, made of soft iron badly grooved and nicked by the points of side tools, during the squaring up process. Here and there a hand or a lathe reamer made for some special job, perhaps in a drawer or on a shelf. If it was a taper reamer, as many of them were, a wrought iron collar shrunk on, said: "Thus far and no farther."

Archimedes' first experience in "chucking" a piece, as it was called, consisted in steering the point of a flat drill, held by the tail center of the lathe and a steady rest, at the center of the rapidly revolving casting, worrying as it wobbled and cheering up as it gradually steadied to its work; then, after the drill was through, following it up with a rose reamer, held in the same manner, and cutting a hole whose size depended entirely on circumstances. Archimedes took the casting out of the chuck, usually burning his fingers in the process, and tried the hole to see if it was "jest a little strong five-eighths" (which it generally was). If the hole was to be a taper, it was finished with a taper reamer wearing a turn-down collar, as before mentioned. This same lathe, by the way, had a chain feed, and when Archimedes took to turning, some later in the course, he soon learned that after setting the tool and connecting up the feed, he would have plenty of time to go to lunch and be back before the tool began cutting. Turning in those days meant turning iron and not steel; very little steel was used except for tools, and soft, or machinery steel was comparatively unknown.

When Archimedes got his first order to turn up some iron shafts, he felt so large that his hat-band cracked. To measure off the iron, to have another man to help him cut it with sledge and cold-chisel, to hold the chisel himself and make the other fellow do the striking—all this was rapture. At first he managed to hold the chisel askew and cut a fine spiral on the round iron, and he trembled a little when the sledge came down. The centering, the straightening, the squaring-up were all tantalizing preliminaries to the final delight of sitting still and seeing the lathe do the work. The pattern was a hard-wood stick with certain cabalistic notches to indicate bearings, taper fits, screw-threads, etc., and marking was done with a file on the rough iron. If the lengths came within a sixteenth, it was close work. As to sizes, well, if it was a journal, Archimedes set his calipers to a "scant five-eighths" on his steel scale, by thumping them on the edge of the tail stock, and turned the iron by them. And, oh! the sandy seams in that iron, the springing of it, and the shaving which got in the center at the finishing chip, and the filing to bring it to size! He tried it finally by one of those same cast-iron boxes which he had chucked, and as it did go in and did not rattle very bad, he ventured to show it to Ammer. Ammer "guessed it would do, but you might make the others just a shade larger." The limit of error in a country job-shop is either a "shade" or a "hair." The day of the snap gage or the hardened plug and collar was not yet. But when the lathe went well and while the chain feed was catching up, Archimedes started to make some tools for himself, which was one of the unwritten privileges of the shop. He cut a pair of calipers of fantastic shape out of sheet steel, riveted them together and spent all his spare moments filing them and rubbing them with emery cloth. Old Carl made him a hammer, and he drilled and filed and polished this until it was ready to harden. And so on, with chisels, gages, scribers, etc., until his tool drawer was filled with a motley assortment.

One day Ammer came to him with a new job, a shaft or arbor to be turned and to have fastened on it two cast-iron hubs or flanges. Ammer said they must be shrunk on. Archimedes did not know exactly what this meant, but he shrank from saying so. He went to a shopmate and asked him about it. The man said: "Oh, you bore the flanges a little small, heat 'em, slip 'em on and jest let 'em cool. It's dead easy." "But how much small?" persisted Archimedes. "Oh, jest a hair, jest so they won't slip on." "And how hot do they want to be?" "Jest a dull red sos't you can see it." Archimedes concluded it was all a "jest," but he soon learned better. He turned his shaft, and bored his flanges "jest a hair" small as near as he could estimate, and satisfied himself that they would not slip on. He then built up a roaring fire on the spare forge and laid one of the flanges carefully over the hot coals. After watching it a few minutes, he went into the shop to get the shaft. When he returned something was amiss. The hub was on the fire red-hot, but nearly half the flange had disappeared. And thus Archimedes learned how to melt cast-iron.

Fig. 3.

Nothing to do but to wait until they cast again at the foundry and then bore out another flange. This time better luck, and the flange was heated uniformly to a dull red, the shaft fastened in a vise near by and the flange started carefully on. Methinks, though, the "hair small" must have been a coarse one, perhaps of the blacksmith variety, for when about half way, the casting

goes slower, hesitates, and "who hesitates is lost" on a shrink fit. Yes, it has "stuck" about half an inch from home and a big lump sticks in Archimedes' throat the rest of that day.

Notwithstanding his various mishaps, Archimedes is slowly but surely advanced from little to big and from simple to complicated jobs. Some of the jobs in a country shop are pretty complicated and require a deal of ingenuity and close thinking. There are no special tools, no jigs and templates to work by. Never a job just like the present one before and probably never will be again. Make your own face-plate and chuck, your own drill and reamer, block up the headstock if the lathe be too small, and run the tailstock out on blocking if the ways be too short. Anything to get there. And what a lot of moral courage it takes to make a big fit by calipers when there are no gages. There is the big pulley or gear on the floor with the hole bored to some size which cannot be stated in inches. Here is the big shaft in the lathe ready for the finishing cut. You set the springy inside calipers or perhaps file a wire to fit the hole and wag them back and forth and twist them around until you think they just touch. You lay them on the bench with the points projecting over and try to fit the equally springy outside calipers to them. Then you try to remember just how tight the inside calipers fitted the hole and just how tight the outside fitted the inside, and compare these vague memories with the feeling of the shaft under the calipers. You try the hole in the wheel a dozen times, you change your calipers a little each time, and your memory and your judgment seem more unreliable each time. You feel like the English carpenter who tried to go through London streets with the measure of a door between his hands. And, oh! the terrible, sickening anxiety when you first try the shaft in its place, for fear it may slip in up to the shoulder and then "wobble!" Of course, the chances are that it will not go in at all, for you have been scared and nervous all along and have not dared to trust your own measurements.

Archimedes will never forget one experiment of his with a big cast-iron shaft. I think he managed the turning all right this time and made no serious blunders. But when the shaft came from the foundry there were one or two places in it that looked rather worm-eaten. Ammer said babbitt them and

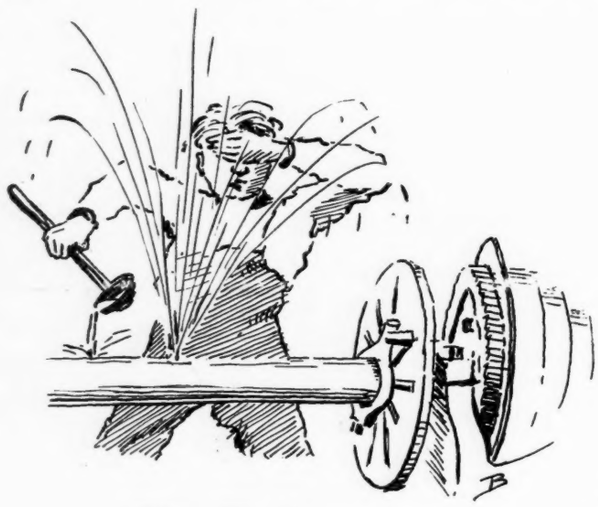


Fig. 4.

Archimedes had no choice but to obey, although his conscience troubled him a bit. He got the shaft on the centers in the big lathe and turned the biggest blow-hole uppermost, then went to the blacksmith shop, hunted up the ladle and some loose pieces of babbitt. It did not take long to melt the metal, to carry it to the lathe and to pour a table-spoonful into the hole. But as luck would have it, the shaft had lain out of doors several days, and tucked away in the corner of this hole was a drop of water. When he saw the hot babbitt coming this drop just arched his back and spit, for all the world like an angry cat, while Mr. Babbitt backed out in a hurry. Archimedes got most of the charge in his face, and for a few minutes looked like a silver-plated teaspoon. Fortunately, he shut his eyes in time, and after his mate had peeled off the plating, he was not much the worse for wear. Archimedes always regarded this as a judgment, but he could not see why it should have hit him instead of Ammer.

Speaking of babbitt, why "babbitt," what is babbitt and who was Babbitt? Was he the soap man, and why did he invent and give his name to this nondescript hybrid among metals? Old Carl, the blacksmith, had a very poor opinion of this particular metal, for every journeyman and apprentice melted babbitt at the forge and managed to spill some in the process. In time the tuyere would get pretty well plugged and Carl would have to go into the mining business.

There was a journeyman in the machine shop whom we will call George. Now, George was of a rather irascible temperament and would let his angry passions rise on very slight provocation. It so happened that he was instructed to straighten and turn a piece of two-inch iron shafting some ten or twelve feet long. Quite recently he had learned that if a slack place in a shaft was pened with the round end of a hammer, the metal would be drawn out and the shaft straightened at that point. He had not learned that such conversion was only skin-deep. This was a very crooked piece of iron with many short yanks in its length. George centered it with care, squared up the ends and proceeded to correct the yanks by wedging up under them and pening the concave side. After a patient, faithful treatment he in time got the iron tolerably straight. He then adjusted his steady-rest and collars, his roughing tool, his finishing tool and his drip of soapy water, and proceeded to turn the shaft in the highest style of the art. As he went along he noticed that the turned portion acted rather funny, but he had been out late the night before and thought the trouble must be in his eyes. And now the turning is done and George removes the restraining rests from the shaft and speeds up the lathe "to see how she runs." Well, she ran like an animated cork-screw.

Fig. 5.

Archimedes heard an oath, a ripping and smashing and looked around just in time to see the shaft flash through the air, thrown by the muscular arms of the angry lathesman and fall writhing upon the floor like a wounded snake. Archimedes retired to a pile of shavings in the planing mill, where he could have his laugh out unobserved, and when he returned he found the somewhat sobered George going through another pening process on the turned shaft.

* * *

Malleable cast iron is a metal obtained from fine-grained cast iron of good quality, from which certain quantities of carbon have been removed in the process of its production. The lower the carbon, the softer and more ductile is the metal and malleable iron, being lower in carbon than gray cast iron, is better able to withstand blows and shocks without breaking. The decarburization is accomplished by packing the castings in some oxidizing agent, like hematite or rolling mill scale. The carbon of the iron then unites at the high temperatures to which the iron is subjected, with the oxygen of the agent, forming carbon oxide.

THE CONVERSION OF FORMULAS.

FROM METRIC TO ENGLISH UNITS—PRACTICE FOR THOSE VERSED IN ALGEBRA.

J. J. C.

To be able to convert a formula from one system of units to another system of units, readily and accurately, is an accomplishment that few people—even engineers and mathematicians—possess. The widespread adoption of the metric system by scientists and foreign countries, makes it frequently necessary to change a formula from the metric system to English units, and vice versa. Again, owing to improvements in apparatus and methods, some of the leading constants are being continually changed, thus necessitating changes in formulas in many instances to make the formulas agree with the new values assigned to the constants. For instance, it was only a few years ago that the mechanical equivalent of heat was stated to be 772 foot-pounds in all text-books; the value most generally used now is 778 foot-pounds, and it is probable that this value will be still higher ten years hence. In order to make formulas containing constants whose values have been changed slightly agree with the conditions of to-day, it is necessary to convert them, as it is termed, and it is the purpose of this article to show how this may be readily done.

It is worthy of remark that text-books on mathematics are strangely silent on this subject. There are a number of propositions in algebra that may be used for the conversion of formulas, but they are usually so hidden by their phraseology that they escape our notice when we desire to use them for this purpose.

In order to make the process more easily understood, we will give a few definitions:

A quantity is anything that can be measured.

A unit is that part of the quantity by which we measure the quantity. Thus 42 is a quantity and 1 is the unit by which we measure it; that is, 42 is really 42 1's. 42 foot-pounds is a quantity and 1 foot-pound is the unit; x, a and t are all quantities, but what their units of measure are we do not know until we have agreed to let them represent some particular collection of units.

A unit may be simple or compound.

A simple unit is one that involves only one particular kind of quantity, as: 1 foot, 1 degree, 1 pound, etc.

A compound unit is one that involves more than one kind of quantity, as: 1 foot-pound, 1 foot per second, 1 pound per square foot, 1 foot-pound per second, etc.

A constant quantity, or constant, is one that does not change its value after a value has once been assigned to it.

A variable quantity, or variable, is one that has its value constantly changed to meet changing conditions. Thus, in the formula, $v = 32.16t$, v and t are variables and 32.16 is a constant that is usually represented by g; that is, we usually write the formula $v = gt$. In this formula we may change the value of v or t as much as we please, but the value of g is not changed owing to a change in v and t. Constants are usually represented by the first letters of the alphabet, a, b, c, etc., and variables by the final letters, as p, t, x, y, etc.

The reciprocal of a quantity is 1 divided by the quantity; thus, the reciprocal of a is $\frac{1}{a}$; of $\frac{1}{3}$ is $\frac{1}{\frac{1}{3}}$ or 3; of $x + a$ is $\frac{1}{x+a}$; of $\frac{1}{2z+1}$ is $2z + 1$, etc.

The first great difficulty that one strikes in converting formulas, is the converting of compound units. For instance, how can we change meter-kilograms to foot-pounds? This is easily done as follows:

Write the equation 1 meter-kilogram = a foot-pound; or letting m represent meter, K, kilogram, f, feet, and p, pound, $mK = afp$. In this equation, m, K, f, and p may be regarded as variables and a as a constant whose value we are to find.

It is a principle of arithmetic that if a quantity be both multiplied and divided by another quantity its value is not altered. For instance, multiplying and dividing 2 by some number, as 5, does not alter the value of 2; for $\frac{2 \times 5}{5} = 2$. This is the principle that we shall use to convert our formulas.

In the formula given,

$$m\,K = a\,f\,p.$$

We know that 1 meter contains 3.2808693 feet and that 1 kilogram weighs 2.2046223 pounds; hence, multiplying and dividing m and K by these constants, we have

$$\frac{[m \times 3.2808693] \times [K \times 2.2046223]}{3.2808693 \times 2.2046223} = a\,f\,p.$$

Now, calling the quantities enclosed by brackets m_1 and K_1, respectively, and dropping a, we have

$$m_1 K_1 = 3.2808693 \times 2.2046223\ f\,p = 7.2330776\ f\,p.$$

That is, 1 meter-kilogram = 7.2330776 foot-pounds, say 7.233 foot-pounds. We will now work a number of problems that will illustrate the method in all its phases.

Problem 1.—Change kilograms per square meter to pounds per square inch.

Solution.—The word per as here used always means division Hence, 1 kilogram per square meter may be expressed as $\frac{K}{m^2}$. But, when a quantity is to be divided by another quantity, the same result may be obtained by multiplying the dividend by the reciprocal of the divisor. For instance, $8 \div 2 = 4$; but the result 4 may be obtained by multiplying 8 by the reciprocal of 2, thus: $8 \times \frac{1}{2} = 4$. Hence, $\frac{K}{m^2}$ may be expressed $K \times \frac{1}{m^2}$ and since 1 m = 29.370432 in.

$$\frac{[K \times 2.2046223]}{2.2046223} \times \frac{39.370432^2}{[m^2 \times 39.370432^2]} = a\,p \times \frac{1}{1^2}$$

in which 1^2 represents square inches.

Whence, dropping a, and using subscripts as before,

$$\frac{K_1}{m_1^2} = \frac{2.2046223}{39.370432} \times \frac{p}{1^2} = \frac{1}{703.0823} \times \frac{p}{1^2};$$

that is, 1 kilogram per square meter $= \frac{1}{703.0823}$ pound per square inch, or 1 pound per square inch = 703.0823 kilograms per square meter.

Problem 2.—The formula giving the total heat of steam above the freezing point is $H = 606.5 + .305t$, in which H is the number of thermal units and t is the temperature Centigrade. Convert the formula so that H will be measured in British thermal units and t in degrees Fahrenheit.

Solution.—One thermal unit $= \frac{9}{5}$ British thermal units, and $1°C. = \frac{9}{5} \times 1°F.$ But, since the temperature t is measured from the freezing point, or 0°C., 32° must be subtracted from the temperature Fahrenheit before substituting in the formula, or else the constant 606.5 must be altered. We will try both ways.

$$H = 606.5 + .305\,t; \quad \frac{[H \times \frac{9}{5}]}{\frac{9}{5}} = 606.5 + .305\,\frac{[t \times \frac{9}{5}]}{\frac{9}{5}}$$

$$H_1 = 606.5 \times \tfrac{9}{5} + .305\,t_1 = 1091.7 + .305\,t_1.$$

In this formula 32° must be subtracted from the temperature before substituting for t_1, as the zero point on the Fahrenheit scale is 32° below the freezing point. Since this is somewhat inconvenient, we replace t_1 by $t_2 - 32$, and we have $H_1 = 1091.7 + .305\,(t_2 - 32) = 1091.7 + .305t_2 - 9\ 76 = 1081.94 + 305t_2$. Therefore, dropping the subscripts,

$$H = 1081.94 + .305\,t.$$

Problem 3.—Rankine's formula for the expansion of saturated steam is $pV^{\frac{17}{16}} = 475$, in which p is the pressure in pounds per square inch and V is the volume in cubic feet. Convert so that p will be in kilograms per square meter and V in cubic meters.

Solution.—Referring to Problem 1 and using but five significant figures, 1 cu. ft. $= \frac{1}{3.2809^3}$ cu. m., and

$$\frac{\left[p \times \frac{1}{2.2046} \times 39.37^2\right]}{\frac{1}{2.2046} \times 39.37^2} \times \frac{\left[V \times \frac{1}{3.2809^3}\right]^{\frac{17}{16}}}{\left(\frac{1}{3.2809^3}\right)^{\frac{17}{16}}} = 475;$$

$$\text{or } p_1 V_1^{\frac{17}{16}} = \frac{39.37^2}{2.2046 \times 3.2809^{\frac{51}{16}}} \times 475 = 7,567.5.$$

Dropping the subscripts,

$$p\,V^{\frac{17}{16}} = 7{,}567.5.$$

Note.—It was necessary to raise $\left(\frac{1}{3.28093}\right)^3$ to the power indicated by the exponent $\frac{17}{16}$, because $V^{\frac{17}{16}}$ had to be multiplied and divided by the same quantity, and this quantity had to be affected with the exponent $\frac{17}{16}$ since the variable V had to be changed to another variable V_1 having the same exponent. We knew the relation between V and V_1 (which was $V \times \left(\frac{1}{3.28093}\right)^3 = V_1$), and we reasoned that

$$\left[V \times \left(\frac{1}{3.28093}\right)^3\right]^{\frac{17}{16}} = V_1{}^{\frac{17}{16}} = V \times \left(\frac{1}{3.28093}\right)^{\frac{51}{16}}$$

Problem 4.—The formula for the velocity of escaping steam is

$$w = 4.43\sqrt{\frac{m\,p\,v}{m-1}\left[1-\left(\frac{p_1}{p}\right)^{\frac{m-1}{m}}\right]}$$

in which w is the velocity in meters per second, p and p_1 are pressures in kilograms per square meter, v is the specific volume, that is, the volume (in cubic meters) occupied by 1 kilogram of steam, and m is a constant. Convert so that w will be in feet per second, p and p_1 in pounds per square inch, and v the volume (in cubic feet) occupied by 1 pound of steam.

Solution.—We have, see Problem 1,

$$\frac{[w \times 3.2809]}{3.2809} = 4.43\sqrt{\frac{m}{m-1} \times \frac{\left[p \times \frac{1}{703\ 08}\right]}{\frac{1}{703.08}} \times \frac{\left[V \times 3.2809^3 \times \frac{1}{2.2046}\right]}{3.2809^3 \times \frac{1}{2.2046}}\left[1-\left(\frac{p_1}{p}\right)^{\frac{m-1}{m}}\right]}$$

It is not necessary to perform any operation on the fraction $\frac{p_1}{p}$, because the same operation will be performed upon both variables, and will cancel each other; that is, the result will be the same as multiplying both numerator and denominator of a fraction by the same quantity—the value of the fraction is not changed, and may be reduced to its original form.

From the foregoing we derive

$$w_1 = 3\ 2809 \times 4.43\sqrt{\frac{m\,p_1\,v_1}{m-1} \times \frac{703.08 \times 2.2046}{3\ 2809^3}\left[1-\left(\frac{p_1}{1}\right)^{\frac{m-1}{m}}\right]}$$

$$\text{Or, } w = 96.288\sqrt{\frac{m\,p\,v}{m-1}\left[1-\left(\frac{p_1}{p}\right)^{\frac{m-1}{m}}\right]}$$

(To be concluded.)

* * *

EARLY COTTON SPINNING MACHINERY.

W. Midgley.

Amongst the varied collections at Chadwick Museum, Bolton Lane, England, there is none more interesting and appreciated than the unique collection of eighteenth century machinery. Here may be seen an old one-thread wheel and distaf, a hand card, the "Jenny," the power-card and "water-frame," together with a piece of old square wooden shafting taken from the mills of R. Arkwright at Cromford, Derbyshire. Here is also preserved the hand mule of Samuel Crompton, a native of the town.

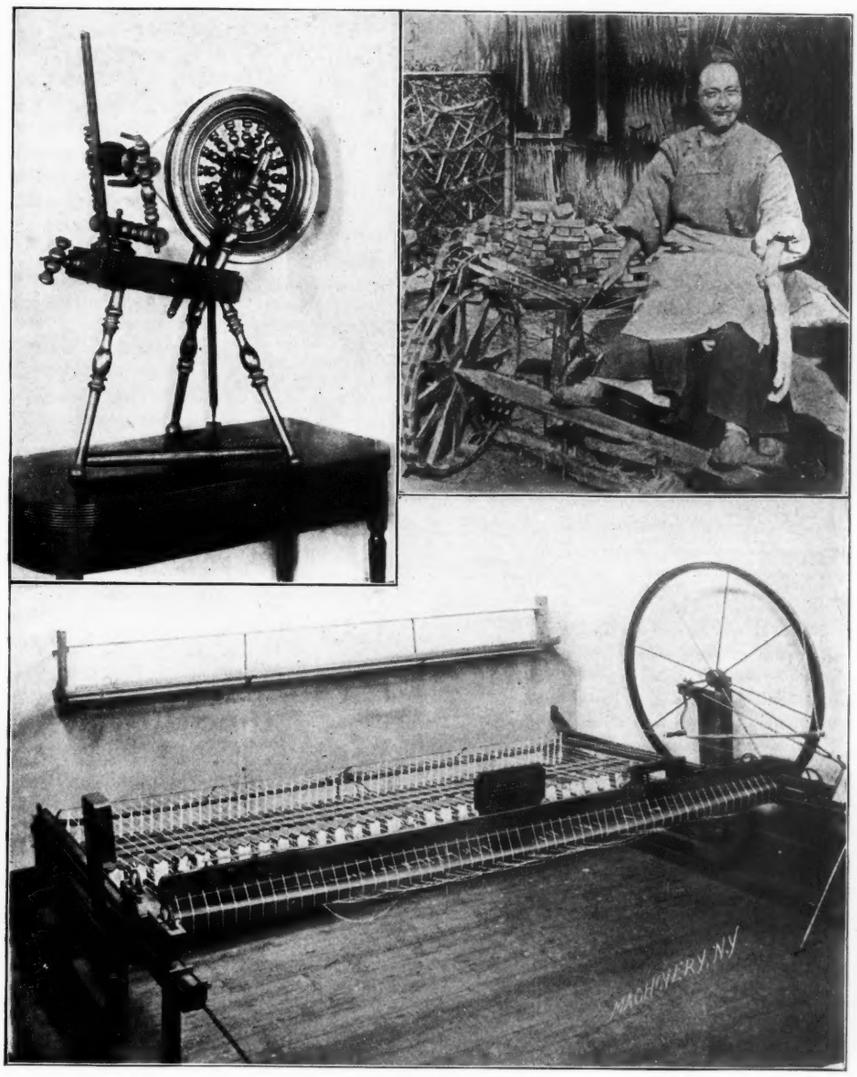
In this age, when everybody's attention is directed to pressing forward in the race for wealth or economy of production, we propose, at the risk of being charged with the "fatalism of looking back," to trace the evolution of the cotton industry of the eighteenth century and lay before the readers of Machinery some account of the inventors and inventions of that period. From the middle to the end of the eighteenth century arose quite a number of independent and original inventions for the production of yarn, and the genius of that time laid the foundation of the prosperity of Lancashire. For centuries the only machine used for spinning cotton was the one-thread or Jersey wheel, which consisted of a large wheel driving a spindle, which twisted the yarn, whilst at the same time it was attenuated by the left hand. This was followed by the distaf, Fig. 1, which combined the spindle, flyer and bobbin for the first time. The bobbin was made to revolve quicker than the spindle, and wind on the yarn, by means of two grooved pulleys of different diameters. The flyer was employed for twisting the yarn and winding it regularly upon the bobbin.

A recent acquisition to the museum is a three-thread wheel, Fig. 2, still used in some districts in China. This machine marks a period between the one-thread wheel and the "Jenny," and is of very rude construction. It consists of a wheel turned by the feet, which gives motion to three spindles by means of a piece of hide passing around them. When the yarn has been drawn out and twisted, it is wound on the spindle in the shape of a cop by means of the stick in the right hand. The operations of spinning and weaving were usually carried on in the same house, the daughters spinning the yarn for their father's loom. The shuttle of the loom had to be thrown through the warp by hand; and with broad looms, two men were required, one on either side of the loom, to throw it across. This was a very slow and costly process, and in 1738 John Kay invented a new method of throwing the shuttle which more than doubled the production of the loom. He lengthened the slay, or board along which the shuttle runs, and by attaching strings to pickers at opposite ends of the slay, and held by a peg in the weaver's right hand he, by a sharp pull of the string, threw the shuttle across the loom. Weavers had now to waste their time in collecting yarn from their neighbors, who fixed their own price and deprived them of their profits.

To bring the supply of yarn into harmony with the demands of weavers, some improvements in spinning had to be made, to increase the production. As early as 1738 we find a patent for "spinning by rollers" taken out by Paul & Wyatt, of Birmingham. A mill was built at Northampton, containing 250 spindles, which was driven by water, but it proved a failure and the venture was abandoned in 1743. Paul took out a second patent in 1758, but it was not until the introduction of the "Jenny" in 1774 that any great advance was made. James Hargreaves, its inventor, was a weaver of Standhill, near Blackburn, and in humble circumstances. The Jenny was intended to spin roving into yarn, and he is said to have received his inspiration through seeing a distaf overturned when the spindle revolved in an upright position. From this he reasoned that if a number of spindles were placed side by side in an upright position, several threads might be spun at once. He contrived a frame, in one part of which eight rovings A were placed, and in another, eight upright spindles B. The rovings were first passed between two bars of wood C D, which could be clasped so as to hold the threads. These bars formed a traveling carriage E, moving to and from the spindles, a distance of about sixty inches. The carriage was drawn out by the spinner's left hand, while with the right he put in twist by means of a hand-wheel G, driving the tin cylinder H. The latter communicated its motion to the spindles by means of cords passing round wharves on the spindles. When the carriage had traveled about three-quarters out, the clasp was closed, thus preventing the further passage of roving; and the threads were attenuated by slowly drawing out the carriage, the thick places being drawn out by the twist first running into the thinner parts and causing them to resist drawing. This made the yarn more uniform in thickness, and the same method is still employed for attenuating waste yarn on the "billey." The carriage was then returned and by letting down the presser wire K, the yarn was wound on the spindle in the form of a cop. With this imperfect machine Hargreaves spun weft for his own looms, but, the secret leaking out, a mob broke into his house and forced him to leave the country. He then erected a small spinning mill at Nottingham, and in 1770 obtained a patent for his jenny, and began to build "Jennies" for sale. Their productiveness being manifest, they were brought into general use. In 1779—a period of distress—a mob destroyed all "Jennies" and "Waterframes" in the Blackburn district, sparing those "Jennies," however, with less than twenty spindles, as these were admitted to be useful. His patent rights were also contested by the Lancashire manufacturers, and he was deprived of their benefit. Although this prevented him from receiving the legitimate

reward of his invention, he continued his spinning concern until his death in 1778, when his widow received £400 for her husband's share in the business, thus proving that he must have spent his last days in comfort.

Hargreaves rapidly improved his machine after taking out the patent. In the first place the toe was dispensed with for working the faller, which was now worked by the left hand. A cord was fixed to a curved portion of the presser M, and passing round three pulleys on one end of the carriage was attached to the outer end of the framing. The center pulley N, slid in a groove and was attached to a latch near the clasps. As the carriage was moving in, the spinner pulled the latch, causing the sliding pulley N to recede from the other two and depressed the faller to the desired level for winding the yarn upon the spindles. Hargreaves also rapidly increased the number of spindles from eight to thirty, sixty and in some machines to 120. In these large machines it was difficult to keep the carriage square and draw all ends alike. To remedy this defect, he attached a band to the framing near the spindles, and passing it round two pulleys, underneath and at opposite ends of the carriage, afterwards fixed it to the outer end of the framing. A similar band was conducted in the opposite direction, and, the same tension existing throughout the length of the bands, the carriage moved out perfectly parallel to the spindles. One of the chief faults about the earliest machines was that the slubbing box being fixed near the spindles, a considerable amount of slubbing hung down when the carriage moved in and was very liable to catch dirt from the floor and also to become entangled and break. He therefore caused the slubbing box to slide to and fro with the carriage, as in the sketch, which considerably reduced the risk of dirty and broken slubbings.



EARLY SPINNING MACHINERY.

Fig. 1. Distaf, combining Spindle, Flyer and Bobbin. Fig. 2. Chinese "Three-thread" Wheel. Fig. 3. Hargreave's Spinning "Jenny."

The above description and photograph are taken from the old jenny in the Bolton Museum, which is probably the only one remaining in England. It had been in constant use for nearly a century, spinning woolen weft for hand-looms in a hill-side house near Slaithewaite, where it was discovered and purchased for the Corporation.

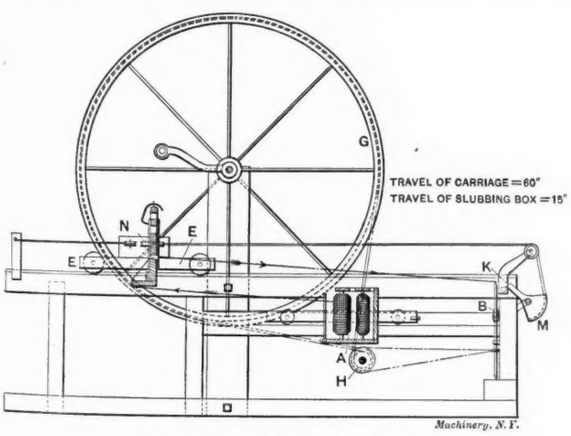
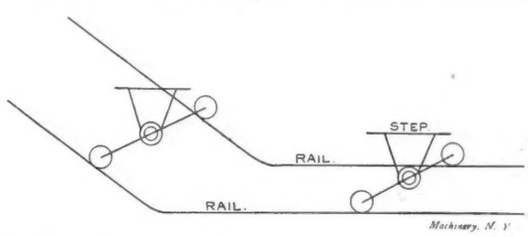


Fig. 4. Details of Spinning "Jenny."

TRAVELING STAIRWAY.

Among the transportation exhibits at the Paris exhibition is a traveling stairway built by the Otis Elevator Company. The general scheme comprises a system of parallel rods connected together and driven by a chain, which carry the triangular supports for the stair treads, as shown in the sketch. The treads are maintained in a horizontal position by two rolls which are connected by short bars to the triangular support, as indicated. These rolls run, one on each of two parallel rails, which are further apart on the incline than on the level. Thus the treads, which form a smooth moving platform at the foot of the incline,



are kept horizontal when they commence to ascend, and there is no tendency to tilt either backward or forward. It is said in the "Sibley Journal of Engineering," from which this information is taken, that this particular stairway is capable of handling, with an expenditure at the motor of from 30 to 35 horse-power, 7,200 people an hour, the height of the lift being 20 feet, 2½ inches and the speed 90 feet per minute.

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MAY, 1900.

The regular edition of MACHINERY for May is 21,500 copies.

MACHINERY has the largest paid-in-advance circulation of any mechanical paper in the world. No subscriber is entered on our mailing list until his subscription is paid for, and all subscriptions are stopped at expiration. Except on special quarterly numbers, no papers are sent free other than to advertisers, exchanges and circulation agents. AMERICAN MACHINERY is the title of the foreign edition, printed on thin paper and comprising all the reading and advertising matter in the domestic edition.

* * *

SOME CIRCULATION FIGURES.

The "American Machinist" has been at last persuaded to give out a circulation statement—of one issue—from which we venture to quote:

On March 26th we counted our list, and it stands as follows:

Paid subscribers	5,399
Advertisers, exchanges and complimentary	812
Sent to London for European edition	3,000
News Company's order	6,550
Total	15,761

The number of paid subscribers accredited to the office is smaller than formerly because the entire European list, once included here, is now included in the 3,000 European edition.

No copies are taken back from News Company as unsold. None go free, regular, to any one without an equivalent.

This may vary next week up or down—if it does we shall print more or less.

This is not a big circulation—but it's the best circulation enjoyed by any paper in our line.

It's a circulation that reaches more men who are responsible for results in shops making all kinds of machinery than all other papers combined.

For purposes of comparison we some time ago estimated the circulation of the "American Machinist" at 12,000 copies, to which add 3,000 foreign papers first printed on March 26, 812 advertisers, exchanges and complimentary, and the total obtained, 15,812, we may fairly claim justifies our estimate.

If the 3,000 copies sent abroad were sufficient to cover the entire European list as well as to place the paper "on sale on the book-stalls in all the manufacturing cities of the continent," how many is the actual paid foreign circulation? How is the statement that the paper is placed on sale, etc., which is quoted from a booklet recently issued by the "American Machinist," and the fact that 812 copies are sent to "advertisers, exchanges and complimentary," reconciled with the assertion that no copies are taken back as unsold and that none go free to any one without an equivalent?

The character of circulation always interests advertisers, and we wish our contemporary had given some facts to justify its claim to have the best. Here are some figures taken at random from our 1899 reports giving a summary of the mechanical readers from a few representative works in different parts of the country. These shops have not been chosen because MACHINERY makes a better showing therein than in others; on the contrary, being old and long established concerns they have been, within a few years, the strongholds of our competitor; and the percentage of MACHINERY readers in some of them is much smaller than in many other shops. We could readily have selected the same number of shops in which every employee, from the head of the concern down, is a subscriber to MACHINERY:

Total subscript'ns in each shop.											
To MACHINERY	60	51	52	72	296	10	110	130	60	33	145
To other Mechanical papers	10	20	15	21	123	0	31	40	10	20	...
Supts. and Ass't. Supts.	2	..	2	2	2	..	3	2	2	..	3
Subscribers to MACHINERY	2	..	2	2	2	..	1	1	1	..	2
Draftsmen employed	5	12	2	5	36	1	25	39	2	4	36
Subscribers to MACHINERY	4	2	2	4	21	1	5	8	1	3	22
Foremen and contractors	9	21	7	..	37	1	37	19	10	..	19
Subscribers to MACHINERY	6	8	4	8	24	1	8	18	8	6	15

So many components now enter into the circulation figures of the "American Machinist"—the "complimentary list, the foreign edition, which is placed on sale on the book stalls, the extra calls, back subscriptions, etc.," that we confess our inability to estimate its circulation; but if our contemporary is really willing to have the actual figures known, let us suggest a plain statement, giving simply the figures for every issue of the preceding year—like this:

The regular editions of MACHINERY *for the last twelve months are given below:*

1899.		1899.		1900.	
June	17,750	November	17,750	March	25,000
July	16,650	December	18,500	April	21,500
August	17,150	1900.		May	21,500
September	18,000	January	20,000		
October	17,500	February	20,500		

L.

* * *

DIAMOND TOOLS IN THE MACHINE SHOP.

While most machinists are quite familiar with the general properties of the diamond and particularly with its extreme hardness, there are, apparently, not many who appreciate its advantages as a cutting tool for many of the regular operations in the machine shop, which are now inferiorly performed with ordinary steel or mushet steel tools. The general use of the black diamond or bort in the machine shop is confined to truing emery or corundum wheels, turning hardened steel, chilled cast iron or similar refractory substances and working hard rubber, celluloid, etc. The use of such tools, correctly shaped for lathe and planer work, for turning, boring or planing brass, steel, cast iron and wrought iron, is as yet extremely limited, although they have been so used in a limited way for many years.

It is well known that the accuracy of many machine tools is quite seriously impaired by the inevitable wear of the tools used for removing the metal. Since the amount of wear on any cutting edge is an extremely indefinite quantity, it is always difficult to determine beforehand what the variation will be from exact parallelism in a piece being turned or bored, or whether it will be plane within close limits when faced in a lathe. If, however, the cutting edge be of a substance that can be used for an indefinite period without showing perceptible wear, even when examined under the microscope, it is evident that one of the chief factors in producing inaccurate work will be eliminated. As the only substance known that will fulfil these conditions is

the diamond, a statement of its limitations and practicable application will be of interest.

The diamond is the hardest of all substances, being rated as 10 in the scale of hardness. The next hardest stone is the ruby, which is rated at 9; but the difference in the hardness of these stones is nevertheless so great that they are comparatively about as hardened steel is to tin. The diamond which is most used and is best adapted to mechanical purposes is the black diamond or bort, which is found only in South America and there only in the provinces of Bahia. On account of the extended use of the black diamond in the industrial arts, the price has been raised by the syndicate controlling the production so that now the retail price is about $38 per karat or somewhat more than the price for the small white diamonds. Although the white diamond is harder than the black variety, it is not as well adapted to mechanical purposes as it has well defined lines of cleavage and will readily split along these lines when subjected to peculiar stress. The black diamond is amorphous in its structure, and is, therefore, more stable as a cutting tool, although somewhat softer.

The proper setting of a black diamond is an art, and shaping and sharpening the cutting edges is said to be a trade secret, since the process used for grinding the white diamond is not successful on the amorphous variety. This fact, together, with the high first cost has naturally restricted the use of such tools to special operations in most cases. It was, therefore, with considerable surprise that in a visit to a shop devoted to the manufacture of certain specialties we saw the commercial use of diamond tools as finishing tools on lathes, boring mills and other machines. On account of the shop policy we cannot, as yet, give much specific information on the subject beyond a brief summary of the possibilities with these tools.

The apparatus made in this shop is of such a nature that it must be extremely accurate in its working and it must also sell at a reasonable price. The materials used in construction include hard rubber, which has to be machined. To those unfamiliar with the properties of this apparently easily-worked substance, it will probably be new that it is one of the most difficult materials to handle with steel tools. In fact, it is impossible to do accurate work on it with anything of less hardness than the diamond. It was thus that in this particular instance an excellent opportunity was given the superintendent to use diamond tools on the different metals, and he has done considerable experimenting in a quiet way with most remarkable results. Articles made of brass are first roughly bored, turned or faced with ordinary steel tools and then the finishing size is obtained, in many machines, with a diamond properly set and shaped. The surfaces produced are wonderfully smooth and accurate, a most difficult condition to obtain in brass, especially with some grades. Cast iron cylinders, perhaps ten inches in diameter and twenty-four inches long, are bored with a variation of from only one-quarter to one-half thousandth of an inch from parallelism. Of course, such results can be obtained with ordinary tools, but only at the cost of great care and attention and with always an uncertainty of how many trials will be necessary to accomplish such refined conditions. With the diamond tools, however, and especially in boring cylinders, this uncertainty does not exist. A cut can be started through a cylinder with the certainty that as far as the tool is concerned the original size will be maintained throughout. In the case of turret tools, the great freedom from error on account of the non-wearing of the tools saves much labor on the part of the tool-maker and enables exact duplication for months with scarcely any attention. To offset these merits are the disadvantages of high first cost, liability to breakage or loss and difficulty in obtaining correct shapes, whether special or ordinary.

Notwithstanding these difficulties, from what the writer saw and was told, it appears evident that diamond tools are destined to play an important part in machine shop operations in the future; but at present the trade appears to be poorly supplied, as there are but few dealers who appreciate the conditions to be met or who will take the pains to ascertain what they are.

* * *

A freak shown by a contemporary is a ball-bearing rifle, which has the remarkably valuable feature of a series of balls in the rifle grooves to reduce the friction of the shot in the bore of the gun.

DESIGNING JIGS AND FIXTURES.

EDWIN C. THURSTON.

One of the problems not easily solved in designing jigs and fixtures is the amount of time that should be spent on a tool. Designing and building are first costs and of more importance than the later expense of repairing tools, which, if well built, need not be much.

If a tool is to be used in the continuous production of pieces, I should take time to consider all conditions. If the tool should be a jig that required turning over in order to remove the work, or to drill holes in different planes, it should be as light as possible, but not so light as to spring in clamping the work, or by the drill pressure. This latter may be overcome by ribbing in places of the greatest strain. I have seen jigs for holding quite large pieces so constructed that they could be turned over with comparative ease, brought against stops located under several drill spindles, carrying drills, bits, counterbores, etc., instead of resetting and changing the tools for each hole. If the drilling operations are all in one plane the jig should be heavier. For milling I should make the fixtures heavier than seems necessary to hold the piece under the cut, so that it will not vibrate or spring. I remember one fixture in particular for holding a fair-sized, irregular-shaped piece that was milled on two faces at one time. The fixture was designed to be quite a little heavier, we thought, than necessary, but it proved none too heavy on trial. Another for the same piece, designed to be strong enough, was not sufficiently rigid to stand up under the cut. A little time spent in designing a tool to look neat and in proportion is not a useless expense.

Why does it take so much time to design a simple tool, is often asked. In the first place, the designer may have a drawing or sketch of the piece operated upon, or perhaps a sample piece; he is told that such holes are to be drilled, such surfaces milled; the drilling is to be done on a certain drill press and the milling on a certain milling machine, or he may choose his machine. The tool must be designed so that it can be used conveniently on the machine, be sufficiently rigid to stand up under the cut without springing, arranged so that the piece operated upon can be securely held and quickly put in place and taken out, surfaces provided for wear, clearance for dirt, burrs, etc. The necessary drawings must be made, giving dimensions and details; there must be work done by the pattern maker, foundryman and tool maker. After all this is done you will find that time has not been waiting.

I have seen tools designed in haste that have come to far from filling the purpose for which they were intended that they either had to be re-designed or discarded. After such a tool is made and even if it has had a fair amount of time spent upon it, one feels greatly disappointed to see where it could be improved, and especially so when others mention how this or that would have been handier or better, and ask why you did not fix it that way.

If a tool must be designed on short notice and the cost figure is set low, give it to a good designer, for with his experience he will probably lay it out the first time so that it will do the work satisfactorily and cost less to build, than if designed by a less experienced and lower-priced man.

In designing, be careful to notice the following: Do not think that after you have your layout complete there is no chance for improvement; before putting on dimensions and detailing, submit it to the foreman who expects to use the tool as well as later to the pattern and tool makers. They may make a suggestion that will be a key to a scheme that you have had in mind but could not get in working shape, so to speak, or they may give you some direct points where the tool could be improved or more easily built. This may mean a new lay-out, but it will be found time well spent and in the end an efficient tool.

Many jigs and fixtures are drawn assembled, with all the dimensions for pattern work as well as for the toolmaker; also sizes of stock screws, washers, etc,. covering the drawing with dimension lines and figures to such an extent that it is almost impossible for the workman to pick out the parts, making the chances for mistakes greater than if the small pieces were detailed and only the figures for the toolmaker given for one or two large pieces on the assembled views. If the pattern figures are desired, take a piece of tracing paper and copy the pieces

separately, giving the necessary figures on these tracings; this will be welcomed by the pattern maker, and the drawing with small parts detailed and only the necessary figures given, will be welcomed by the tool maker, saving more than enough time in building to pay for the extra time spent by the detail man in making the drawings as described.

Do not put bushings, guiding surfaces or supports in a movable piece, such as in a hinge cover or clamps, for there is danger of the bushing or guiding surface not coming to the same place every time. If it is necessary to do so, be sure to have liberal bearings and good fastenings.

Use as few springs as possible, for they are unreliable. I have seen considerable work thrown away just because a spring failed to hold the piece in place; it was either too weak at the start or had been a little too stiff and not sufficiently tempered to keep it from bending under the pressure, thus allowing the piece to get out of place and be spoiled.

Avoid trying to do too much with one tool; for instance, if you design a jig for drilling holes in three or four sides of a small piece and after it is built it is found necessary to change the location of a bushing or bearing, the chances are that the tool maker will have a hard time to make the change and still keep the relations correct, especially where the guiding holes are in the bearings and are in one piece that must be annealed to make the change. If it is necessary to drill several holes as stated, it is better to use separate pieces for the guiding holes, bushings and bearings as far as possible, making a tool that is easier to build; for the tool maker can get the separate pieces made, and set and dowel each one independently of the others. A better way still is to make two tools instead of trying to do so much with one.

Notice that necessary recesses for burrs and dirt are always provided. Cut a groove at the joining of two bearing surfaces in jig or fixture when the piece operated upon has a similar edge; there is almost always a burr on the edge, or dirt is apt to stick in the corner unnoticed, to be discovered after considerable work has been spoiled.

Take the sharp edges off the tools so that a man can handle them without cutting his hands, and if there are handles for clamping, etc., make them such a size and form that it will not be necessary for the workman to have his fingers tied up in rags.

Consider the help you can give the tool maker in providing two or more surfaces that can be planed and used as working surfaces; one of these will answer as a place for marking the operation for which the tool is to be used; also provide lugs or posts for supporting a piece or for locating a center. These can be chipped off after the tool is finished.

If a tool is to be used for a continuous production of pieces, the bearing surfaces should be hardened; and for jigs use hardened steel feet.

Do not make the guiding surfaces for drills too long in the bushing, and if a bushing is inverted, which is done quite often in folding jigs, a piece of hardened sheet steel with a hole a little larger than the drilling tools used should be fastened over the bushings to prevent the destruction of the bearing surface around the bushing. When the drilling tools are small compared to the jig, stops should be provided, as the small drills or bits will not be stiff enough to bring the jig under the spindle, giving as a result a hole on an angle.

On small interchangeable work, the following relations will be found quite satisfactory, when a hole is made with a starting drill, following drill and bit. A starting drill for a hole under 5/16 in. diameter should be .001 in. smaller in diameter than the following drill, or .002 in. smaller if the hole is to be over 5/16 in. diameter. The starting drill should have a shank ground to the same diameter as the bit that finishes the hole; both are to be guided by the bushing, while the drill follows the hole made by the starting drill and does not touch the bushing.

If you are drilling a hole in cast iron, say .250—.251 in. diameter, where the limit is .001 in., have the starting drill .241 in. diameter for cut, following drill .242 in. diameter and the bit .250 in. diameter. If the hole must be within .002 in. limit, that is .250—.252 in. diameter, the same size starting and following drills can be used as before, but the bit should be .251 in. diameter.

In wrought iron and steel, for a hole with .001 in, limit, the bit should be .0005 in. above lower limit of hole and .001 in. above lower limit when the hole is to be within .002 in. limit. For instance, the hole .250—.251 in. diameter should have the starting drill .243 in. diameter of cut, following drill .244 in. diameter and the bit .2505 in. diameter; a little less stock is removed by the bit than in cast iron. Now if the hole is to be .250—.252 in. diameter, the bit should be .251 in. diameter, the starting and following drills remaining the same as for the .250—.251 in. hole.

The hole in bushings for guiding tools for holes over .100 in. diameter, should be .001 in. diameter larger than the bit used, for smaller holes if you wish close work, the diameter of the guiding hole should be .0005 in. diameter larger than the bit.

Make bushings of tool steel, hardened and lapped for guiding drills and bits rather than trying to guide them in holes in the supports or body of the tool; a new bushing could be put in place cheaper than to anneal, bore, brush and reharden a solid piece in which a hole had worn large. Where a large number of bushings are used it might be well to keep some sizes in stock; a little variation could be made in the design of the tool to suit the stock size bushings.

* * *

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

SIMPLE DISTANCE GAGE.

W. G. R. says that a simple yet very convenient distance gage may easily be made like that shown in Fig. 1. The materials necessary are two steel rods and a piece of spring-tempered sheet steel. A convenient size for the rods is ¼" in diameter and for the spring about 4" by 1", No. 20 gage. An elongated hole a

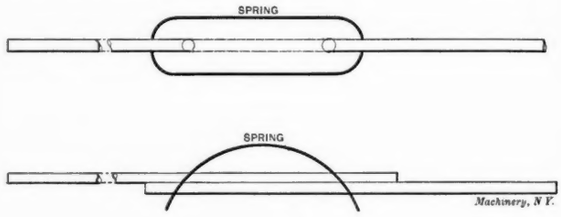


Fig. 1.

little longer than that needed to take in the two rods side by side is made near each end of the spring. The ends of the spring being brought near together, the rods are thrust through the openings and securely held in any desired relative position by the tendency of the spring to straighten out. Different lengths of rods may be provided for varying the capacity of the tool.

TO SET A TAIL-STOCK—DRILL HOLDER—BORING TOOL HOLDER.

M. Long, Geneva, N. Y., says: I have seen a number of ways given for setting the tail-block so that the work will turn straight, some quite elaborate, involving the turning up of a piece, but I never saw any quite as sure and simple as the way I

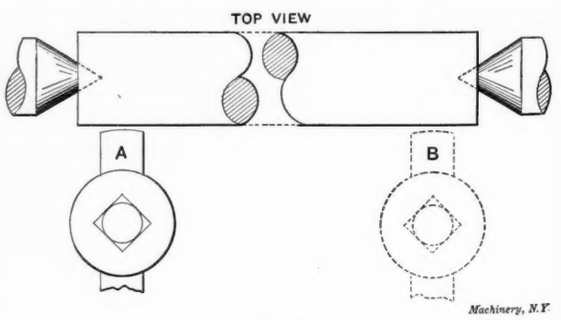


Fig. 2.

do. Take any piece of centered stock or mandrel (preferably about the length of the work to be turned, in order to avoid moving the tail-block) and put it on the centers. Put a tool in the

holder with the blunt end toward the bar. Revolve the bar with the hand and move the tool up until it just touches, as at position A, Fig. 2. Then remove the bar from the centers, move the carriage to position B, at which position the tool should touch the bar at the same place, when turned end for end and replaced on the centers, as it did in position A. Adjust the tail-block until the tool touches the bar the same at both ends. Now, no matter how inaccurately the head and tail-block may fit on the shears, your work will come out parallel (allowing nothing for wear of tool). In this setting care must be taken that the live center is true.

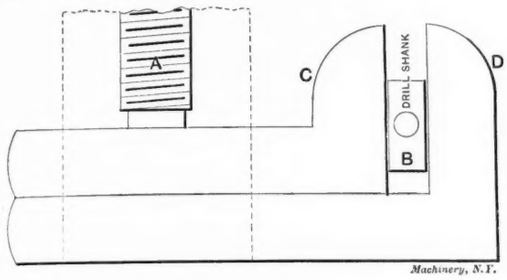


Fig. 3.

The drill-holder, shown in Fig. 3, is, I think, a much better method for holding a flat drill for lathe drilling than the ordinary holder. Two pieces of half-inch square iron are bent up as shown in cut. The drill is placed in position for work, the thumb and finger being placed at C and D. Draw the pieces against the drill and tighten the tool-post screw A on them, and your adjusting is all done. The tool-block does not have to be adjusted up or down, as with the old method, which is handy, especially when other tools are being used. In withdrawing the drill to clean out chips, it does not have to be brought back clear through the holder, but just out of the work and lifted up. I prefer the flat drill to the twist for most lathe drilling.

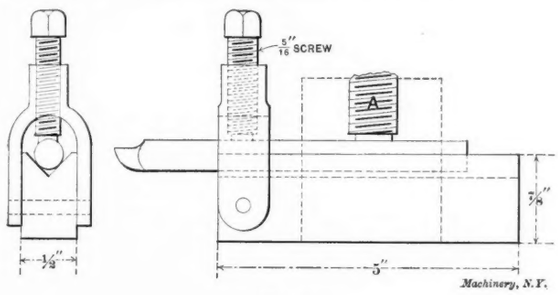


Fig. 4.

I have lately seen some small boring-tool holders illustrated, but I think none of them are quite as handy as one I have, as shown in Fig. 4. (I am not the originator of this tool.) The cutter bar is firmly held as close as possible to the working end and also the whole held by tool-post screw A. It will hold round, square, or octagon steel from ⅛" up to ½" diameter. It is also handy for special tools when turning.

TO MAKE COIL SPRINGS IN A VISE.

Charles W. Dilkes, Plainfield, N. J., says that the following method of making coil springs is handy when a special spring is

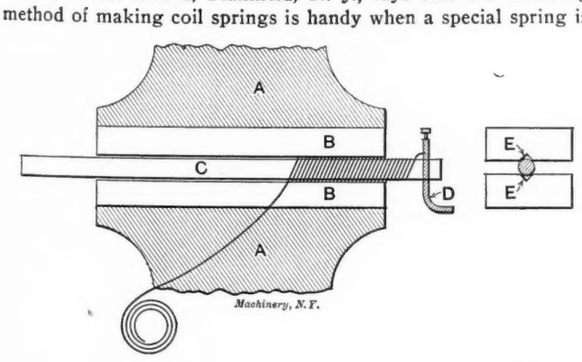


Fig. 5. Fig. 6.

needed in a hurry and the time cannot be taken to rig up a lathe for the purpose. A closed or open spring can be made any desired pitch with a little practice, as shown in Fig. 5. A A represents the jaws of an ordinary machinist's vise, B B two blocks of hard wood, C a plain round steel rod of a size to make the spring required, and D a lathe dog to hold the wire to the mandrel and to serve as a handle. In Fig. 6 an end view of the blocks is shown in which E E are the V-grooves for the mandrel and wire. This device is used in some shops, but is quite unknown in many others.

TWO EXTENSION CUTTER BARS—MILLING RIG FOR THE LATHE.

"R. S.," Fond du Lac, Wis., says that the three following kinks have helped him a great deal in his shop practice.

Figs. 7 and 8 are two forms of extension tool-posts for the shaper. The one shown in Fig. 7 is a straight bar with a shoulder turned at A to fit the tool apron and threaded for the nut C which clamps the post in position. "R. S." says that he has used an extension with success, 14" long and 1" in diameter. In this bar a ¼" square hole was provided for the tool.

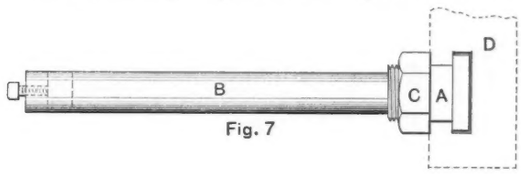


Fig. 7

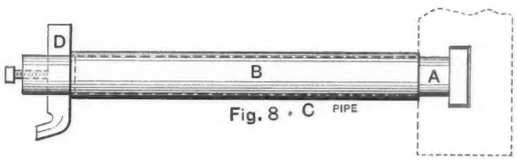


Fig. 8

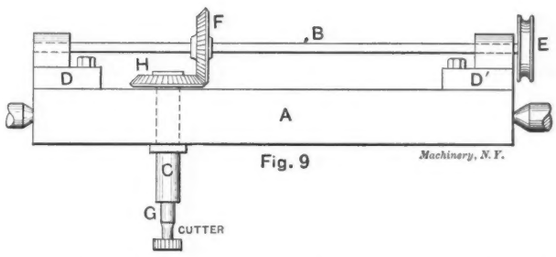


Fig. 9

The extension shown in Fig. 8 is made with a shoulder at A, but instead of being clamped with a nut to the apron, a pipe C is slipped over B, which thus supports the tool D, since the tool slot in B extends within the length of the pipe, as indicated by the dotted line.

The device shown in Fig. 9 is a milling rig for the lathe which has been used to cut a T-slot in a tube when it could not be done on a planer. The bar A is held in the centers of the lathe and the tube to have the T-slot cut is clamped to the carriage and fed along by the lead screw. The power is taken from an independent source through the sheave E which transmits it through the shaft B and bevel gears F and H to the cutter G. The bar A forms a bearing for the spindle C, as shown by the dotted lines.

ADJUSTABLE REAMER—SETTING MILLING CUTTERS.

"D. C. K.," Cincinnati, Ohio, says: Fig. 10 is a sketch of an adjustable reamer, description of which is hardly necessary, as

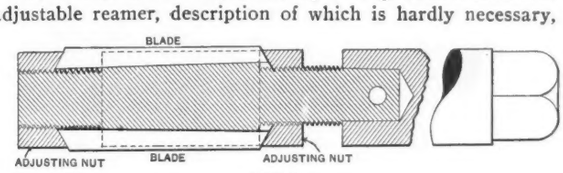


Fig.10

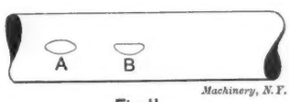


Fig.11

the sketch shows the construction quite clearly. Fig. 11 is a handy kink for a milling machine hand to remember in center-

ing keyway cutters and the like. When the cutter is central it makes a mark somewhat like A on the shaft, and when off center as at B. With a little practice it becomes an easy matter to center a cutter, and it will be found to be a shorter and better way than by using a square and scale.

TAPER INDICATOR FOR THE LATHE.

R. B. Casey, Lancaster, N. Y., says: I enclose sketches and description of a tool which will be of great assistance in setting the tail-stock of lathe to proper distance for turning tapers, and while it may not be of much use to the expert, it will appeal to a large class of workmen who have experienced trouble in that

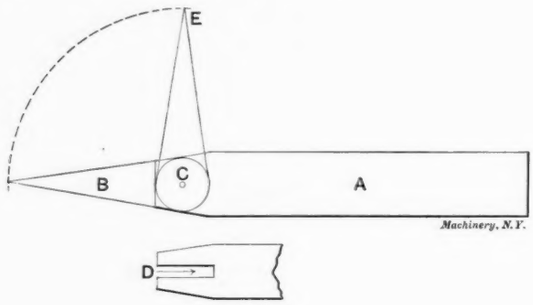


Fig. 12.

line of work, and have (as has the writer) watched the finishing cut fast approaching the shoulder with feelings akin to those of the man with his foot caught in a frog, while the fast express is approaching.

To make the tool, take a piece of flat iron any convenient size, to fit in the tool-post of the lathe, which will serve for the shank A Fig 12; 1″ x ½″ is a good size, and will fit almost any lathe. Saw a slot D in one end of shank, and fit a pointer B of steel in same, securing it with a pin C, using care to have it work easily, without being loose.

Saw the slot back far enough into the shank, so that the pointer when moved to the upright position E, will not fall down while moving the carriage back and forth.

To use the tool, measure accurately on the piece to be tapered the exact length, then cut to size at large and small end; a cutting-off tool should be used when the taper ends at a shoulder.

Use thread calipers in getting the sizes, and be careful to caliper at the exact distance. Place tool in tool-post, and move the tail-stock over till the pointer touches at both points that have been turned to size, then proceed to cut the taper. If care be used in measuring and calipering, the taper will be correct.

CENTERING DEVICE—TURRET LATHE TOOL.

Frank Greiner, New York City, says that Fig. 13 comes in handy when there are a lot of round pieces to be centered, to be turned down afterward. A is the body, made of machine steel. B is made of tool steel and hardened. It is forced away from the body by means of the coiled spring D and is prevented from slipping off by the collar C. The angle in front is about 60° and the pressure of the spring brings the work to the center. The device may either be worked with an ordinary twist drill, or a combination drill and center reamer.

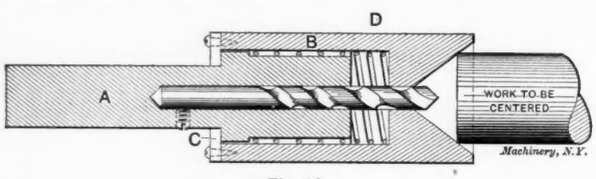


Fig. 13.

Fig. 14 is a pin pointing rig, which has given very good results and which can be used on any screw machine. A shows the body of the pointing chuck, which carries the round cutter B. The bushing C is interchangeable with others for different sized pins. Cutter B rests in a chamber, bored at right angles to the chuck. It need not be any thicker than ⅛″ and can be ground to point any shape. To insure a smooth cut high speed is essential. D is the body of the clamping jig with the hardened jaws E E. The pivoted part F is kept away from D by the spring G, which will release the pin after pointing as soon as F is drawn off the hardened roller H. If short pins are to be pointed another roller may be placed alongside of H in order to hold the pins, until withdrawn from the bushing C. The opening between the jaws is regulated by the screw K in D. The thread on O should be fine, to permit close adjustment of roller H. N is the turret head of screw machine and M is the cross-slide.

The operator holds the turret bed lever with his right hand and feeds with his left. In normal position the clamping jig is

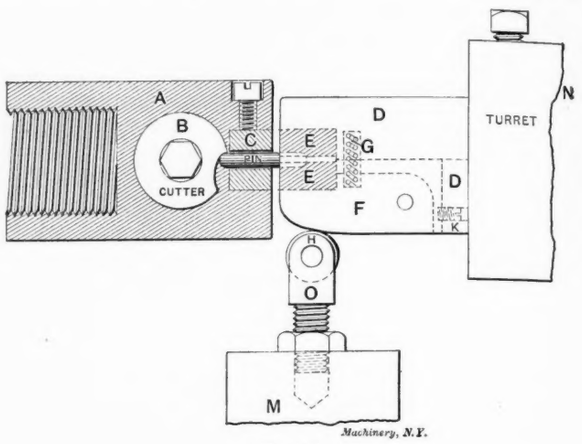


Fig. 14.

pushed away from the chuck just enough to allow the operator to place a pin in bushing C. Then the clamp jig is moved in towards the work. The higher the jig climbs on H, the tighter the jaws grip the work, so that when the cut is at its completion and the tendency of the work to slip in the jaws is greatest, the grip of the jaws is tightest.

As said before, the rig has given satisfaction, and with a live boy behind it, it will easily turn out 5,000 pins (one end pointed) in a day.

KEY-SEATING ATTACHMENT.

B. J. Willey, Louisville, Ky., says that he recently had a number of gears to keyseat and there was no keyway cutter available or even the usual goose-neck tool for the shaper. He made the tool shown in Fig. 15 and found it to be very satisfactory. The length of the tool need be but a little greater than the width of the hub to be keyseated, and is therefore much stiffer than a

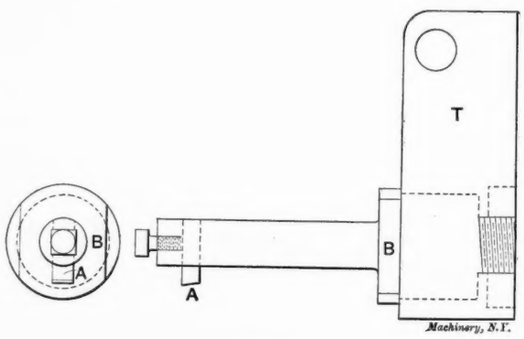


Fig. 15.

forged tool held in the tool-post and projecting out beyond the tool-post screw far enough to cut a keyway of equal length. The cutter A is square and made of self-hardening steel. The flattened shoulder B gives means for screwing the shank into the tool apron.

OLD RAKE TEETH VALUABLE.

"Crandall" says that he has found old rake teeth from the junk yard to be quite valuable in the shop, as they can be forged and tempered the same as tool steel. For making punches, screwdrivers, flat drills (for drilling out broken set-screws in the hubs of pulleys), small chisels and other tools, they answer just as well as commercial steel. Old files are also good for making tools if the cuts are well ground out before forging.

LETTERS UPON PRACTICAL SUBJECTS.

HARDENING HAMMERS.

Editor MACHINERY:

I have noticed your description of how to harden a hammer, given in answer to J. A. C., in April issue.

As you say, a hammer should not be hard at the eye if it is to be used. My method of tempering a hammer is to heat it on an iron rod, allowing the rod and all to get hot together. When at the proper heat dip the ball in the water to the proper depth, and at the same time have a small stream of water, say one-quarter inch diameter from hose or tank, poured on the center of the face. When properly cooled, polish ball and face quickly and allow the heat of the eye and rod to draw both ends to the proper color, when it should be dipped.

By this method the center of face can be made extremely hard, to prevent battering, while at the same time the outside can be comparatively soft and not liable to chip or spall off. The ball will be hardest at the extreme point, where it is most used. The center of the hammer will be soft as it should be.

When hammer faces are dipped the outside corner or rim is chilled first, making it very hard or brittle, while the center may be too soft, and batter.

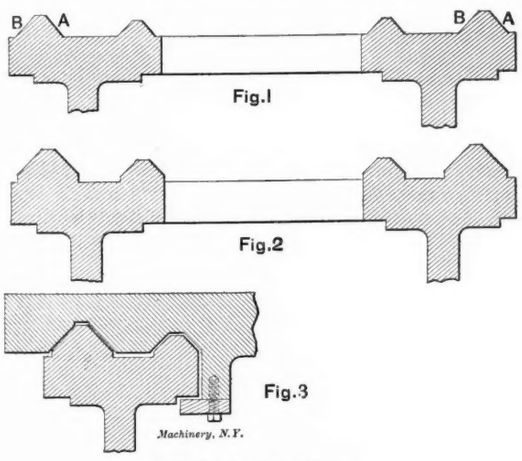
I have used this method for years and can recommend it as being first-class. HUGH HILL.

* * *

LATHE SHEARS.

Editor MACHINERY:

That the lathe is the most important of all machine tools is manifested by the great amount of thought and study given to it by designers and mechanics. It is the aim of the designer to construct a perfect machine, at the same time to try to provide means for keeping all parts in perfect alignment, and, if possible, to overcome the evil effects of wear. It is not necessary to point out the great progress made in this direction; the present standard lathe speaks for itself. It would seem, however, that in most makes of lathes there has been no provision made for the wear on the V shear on which the carriage moves. The V shear is on these lathes like Fig. 1., the V way of the



Sections of Lathe Shears.

carriage fitting about two-thirds of the depth. While wear on the V way of the carriage will be mostly vertical, it will not be so on the V-shear. If the lathe is turning up some work, the line of resistance on the V-shear will be at A A, and when boring at B B; consequently in a short time a well developed shoulder on the V shear is soon obtained. By using a clearance V-shear as shown in Fig. 2, and having the V-way of the carriage clear over the edge of the V-shear as shown in Fig. 3, the wear will be reduced to a minimum, and leave no shoulder for the carriage to rock on. This style of V-shear is not new, but time has proven it to be superior to the ones in general use, and it seems strange to me that it is not more generally adopted by machine tool workers, not particularly on lathes, but on planer tables and all parts of machinery having a wearing surface. I notice that several makers of lathes are adopting this clearance style of V-shear, but some of them do not fully clear the edge of the V-shear with the carriage way.

The principal accessory to the lathe, and one that seems to be sadly overlooked, is the steady rest. Its progress has been like its name—a steady rest. Of course, some finishing touches have been given to it in regard to its design, but its usefulness as a steadying rest is still limited. Its capacity should be equal to swinging over the saddle of the lathe and at the same time it should be rigid enough to support the end of any piece that the lathe could swing. It would seem that some of the present steady rests were more adaptable for gun sights than for steadying heavy revolving pieces in the lathe. T. B. C.

* * *

COTTER PINS.

Editor MACHINERY:

Recently I observed a peculiar accident, which suggested to me that a more liberal use of cotter pins in engine construction would be an advantage. The accident in question was that of one of the revolving weights of a governor on a Corliss engine coming off and dropping to the floor while the engine was in motion. It appears that the motion of the governor exercised an influence tending to give the weight a revolving motion on its stem, which caused it to unscrew the holding nut, allowing the weight to drop. This apparently had no effect on the speed of the engine, and no damage resulted; but it occurred to me that if the nut had been secured from turning by a pin or its equivalent it would have been safer.

In this connection I recall two serious accidents to large engines, which happened in my presence. In one case a vertical and in the other a horizontal engine were wrecked because the key holding the piston rod in the cross-head came out. One of these engines was new and had been running under load about twenty minutes. In either of these cases, if the end of the key had been drilled and a simple split pin been inserted, which would have cost only a few cents, it would have resulted in a saving of many dollars, because this would have been sufficient to prevent the key getting out. This is a point appreciated by locomotive builders who quite generally employ this inexpensive and most effective safeguard.

A. BEMENT.

* * *

CONSERVATISM IN MACHINE SHOPS.

Editor MACHINERY:

I noticed a brief editorial note in the April issue of MACHINERY on the difficulty experienced by those interested, in obtaining access to the manufacturing establishments in England and the subsequent discovery of bald and ancient practices when such admittance was finally granted. The concluding sentence intimating that such occurrences were not infrequent in this country has often been borne out by the writer's experience in some of his peregrinations around the country in search of a job or when just "rubbering" for information.

One such instance I recall as having occurred right here in New Jersey. Being considerably interested in the product of a well known firm I ventured to ask permission one day to take a look through their establishment, with the idea of possibly picking up some mechanical information which might be of value in the dim and distant future when Perry became a superintendent. To my surprise and chagrin, admittance was promptly and almost savagely denied. It was intimated that they (the firm) were in business for what there was in it and not at all on account of the salubrious conditions. From the latter remark I suppose that their health was meant. Not caring to be turned down in such an unceremonious manner, I managed eventually to win the good graces of the superintendent and at a later visit was duly ushered into the "Holy of Holies." Great Caesar! What a falling away from expected conditions was my experience upon actual realization. The practice was in many instances entirely out of date and a number of jobs in progress were being done in a way that was extremely expensive when compared to what is possible with the improved machinery provided for such work, or unnecessary as is proved by contemporaneous practice.

I was shown with some pride a planer which was being used

for planing two heavy castings which were entirely too large and heavy for the capacity of the machine. To handle them, it was necessary to remove the cross-rail and substitute a jim-crack from the housings to support the tool. Of course, the handling of such castings displayed a certain amount of skill and management on the part of the mechanic in charge, especially when it came to oiling the ways, as it was necessary to run the platen back every few minutes to deluge them with oil to prevent cutting. The obvious remedy for this condition of affairs was a larger and better proportioned planer, as the character of their work continually demanded a tool of greater capacity.

A heavy combination machine for doing two operations simultaneously was exhibited as a tool developed and built expressly for their work and reference was made to the attempt of a representative of a well-known mechanical journal to photograph and describe it for the benefit of their readers, and how he was severely turned down. While I have no reason to disbelieve that the machine was developed in this shop, and that at one time it represented a valuable asset, it is now entirely without novelty, as it is being duplicated in the product of a tool-building firm, with many impovements that experience and the suggestions of users have made possible. An ancient boring mill was also cautiously shown as another machine developed and built here. As a relic of bygone times it was interesting, but as part of an equipment liable to be copied by competitors, it was simply ludicrous.

In conversation with the superintendent, who, by the way, is a most worthy man, the idea was gained that whatever the firm have discovered or developed is regarded as their private property, and that no possible good could come by the general admittance of other members of the craft to their shops. The belief was expressed that mechanical journals as a rule were of more detriment to the interests of manufacturers than a help, as they were constantly exposing and giving away secrets that had cost much time and experimental work.

While my experience in the reading of mechanical journals is that much information can be gathered from their columns, I cannot see wherein this information is usually of any material detriment to the shop whose practice is described, unless it be that those responsible for the shop's progress refuse, in their turn, to assimilate the valuable information therein contained which has been gathered from other sources. The interchange of ideas which has been so prevalent among the more progressive shops of America, is one important factor that to-day makes her the leader in the machine tool building trade. The shop superintendent or proprietor who does not assimilate new ideas from extraneous sources, and thereby improve his practice, will surely fall behind the procession unless he be of extraordinary ingenuity and possessed of great mental resources. It is my belief, gathered from quite an extended experience, that the best plan is to freely give of your experience, and in return use that which commends itself to your judgment as being well calculated to improve the quality or increase the quantity of work produced. In this way, and no other, can the average shop keep up to the mark, and as soon as our machine shop proprietors adopt the close Continental method of shop practice, just so soon will they begin to fall behind in the industrial race. (At least this is my humble opinion.) R. P. PERRY.

Hoboken, N. J.

* * *

SPIRAL GEARS.

Editor MACHINERY:

A short time ago I was looking through a gas engine shop in western Pennsylvania. In the course of conversation the subject of spiral gears came up, and the mechanical superintendent stated that formerly they had been in the habit of having the gears cut by outside parties, but that, as he thought the prices charged were very high, he devised a method of casting the gears. The mold was made from a cut pattern, but here came the trouble of pulling the pattern from the mold. This is the way this difficulty was overcome. The metal pattern was placed on a smooth surface and a border put on about an inch and one-half away from the gear and then a casting of babbitt metal was made, making a thin internal gear about one-fourth inch thick. This gear was carefully trued, and placed over the pattern in the sand, then by a careful twisting motion the pattern was pulled from the sand, leaving a perfect mold. The castings were very smooth, required very little trimming and ran very smoothly, and the scale surface, the superintendent informed me, added considerably to the moving qualities of the gear. No doubt, this process is old to some of your older readers, but it may be new to the younger mechanics. F. H. JACKSON.

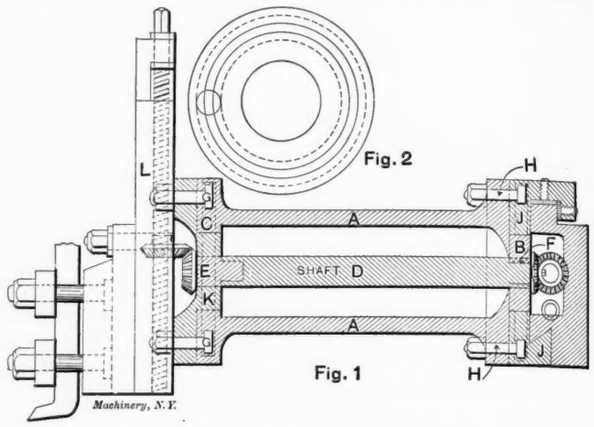
* * *

EXTENSION TOOL-HOLDER FOR PLANER.

Editor MACHINERY:

I send you a sketch of a rig that will enable a small planer to take in work that it could not do without an extension tool of some kind.

It consists of a cylindrical casting A Fig. 1, an end view of which is shown in Fig. 2 where the dotted lines represent the T-slot cut out to receive the bolt-heads of Fig. 1. This enables



Extension Tool-holder for Planer.

the head to be used at any angle. The other end of the casting A has four holes drilled in the flange for the bolts H which secure it to the cross-head J.

The boss B is turned to fit the hole in the cross-head, the other end of A being bored to receive the boss K on which the vertical slide L swivels. The shaft D connects the bevel-gears E and F and enables the down feed to be used with the same facility that it would under ordinary circumstances. This device is rigid and convenient. H. D. J.

Hartford, Conn.

* * *

THE ADJUSTMENT OF SHAPER SLIDES—FINISHING CORE PRINTS.

Editor MACHINERY:

I have been paying a good deal of attention lately to the ease with which the gibs on machine tools may be adjusted. I am of the opinion that this in a great many cases is a thing too easily done, especially where the gibs are adjusted with blind set screws. One machine that caught my eye was a shaper that had only

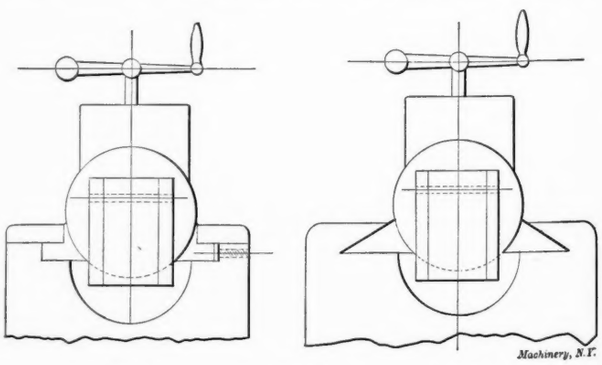


Fig. 1. Shaper Slides. Fig. 2.

been in use about six years and was already in a very bad condition. The ram was of the usual style (like Fig. 1) and adjusted with blind set screws. I found the ram in fearfully bad shape, the slide being all cut and scratched. It was caused by the men in the shop using a screw driver on the set screws when their tool happened to be dull or not in good working order.

In the same shop was a shaper of another style like Fig. 2, with no means of adjustment provided. The slide of this ram

showed not the least sign of wear and had already been in use some fourteen or fifteen years.

Now, there are some who will claim that the men should not be allowed to touch the adjustment on any machine without the consent of the foreman, but the writer knows from experience that they will do this in spite of all orders and in a great many cases do more or less damage to the machine.

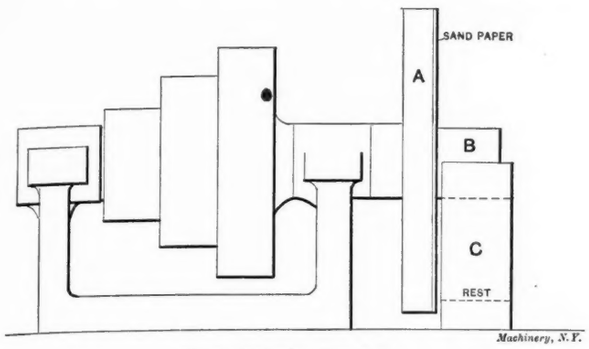


Fig. 3. Finishing Core Prints.

A quick way of finishing core prints that must be in halves is to have a disc A about 12 inches in diameter and glued on this a piece of heavy sand paper. Place it in the lathe and work the stock off the print B as shown in sketch Fig 3. It is surprising what a neat job can be done in about one-tenth the time it would take for screwing them on the face plate and turning them or else working them out with a chisel.

C. C. R.

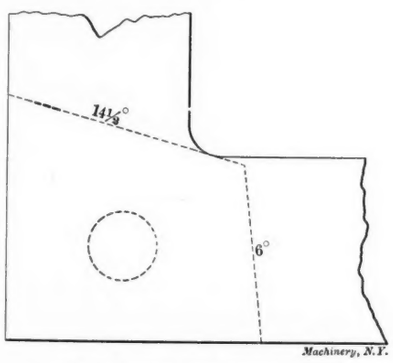
* * *

UTILIZING BROKEN TRIANGLES, ETC.

Editor MACHINERY:

In the March issue of MACHINERY Mr. A. W. Draesch calls attention to a 60 degree triangle, which, being broken off on the 30 degree end, can be used again by cutting it down to 45 degrees.

I have a 12 inch triangle 90, 60 and 45 degrees, which I had made by special order about eight years ago and I find it the handiest of all triangles. I do not think this kind of triangle



Available Section from Broken Triangle.

is anything new for I have seen them used by many draftsmen who have worked in different parts of the United States. I think the trade in general has made many of these triangles on special order. I had a large 15 inch 45 degree triangle which became broken in small pieces and I used the 90 degree corner piece as shown in the enclosed sketch. The 14½ degree angle is a good thing for drawing worms and the 6 degree angle is a very handy angle for drawing threads on screws. Of course, a person could make the 6 degree angle anything he wishes to suit his own notion about drawing screw threads.

I think draftsmen, as a rule, break their triangles in smaller pieces than outlined by Mr. Draesch, so, for this reason, they could be used to good advantage in the way I have described.

If you are fortunate enough not to have any broken triangles to experiment with make one out of wood and see how useful it is.

E. W. BENTEL.

Fort Wayne, Ind.

ADVICE CONCERNING PARIS.

Editor MACHINERY:

I deem it my duty to call the attention of all Americans who purpose visiting the Paris Exposition of 1900, and more particularly those who intend exhibiting, to the necessity of immediate action if they wish to avoid the annoyance, expense and delay which the unsatisfactory postal and railway service are already occasioning, and which will undoubtedly be more than doubled after the great fair opens its gates. These difficulties are aggravated by the insufficient, unsatisfactory and uncomfortable means of local communication and by the avowed intention of hotel and boarding house proprietors to double their rates in May.

To commence with the railway service: The passenger cars, except those of the first class, are dirty and badly heated, the second class being less desirable than the German third. One can of hot water lying loose on the floor serves to heat a compartment containing eight people on a four and a half hours' run, with the outer air at—11° Centigrade = 12° Fahrenheit. This evil does not, of course, bid fair to affect summer travelers, except that it shows bad management and indifference to passengers' comfort. As regards delays in the service, the train for Calais, which should reach the Gare du Nord or Northern Station at Paris at seven in the evening, got in yesterday at 8:20; a delay of an hour and twenty minutes on a trip which by the time-table should take but four hours; and there is no snow. This is not an exceptional case on this line, as it happens about every two days that there is a delay of from twenty minutes to an hour. The evil is so serious that it is proposed by the French public to have a law passed by which when there is a delay of over ten per cent. of the normal duration of the run the companies shall refund half the price of the ticket.

The recent tail-end collisions, in two successive days, and in one of which there was one person killed and twenty wounded, point to the absence of a block system or of means to enforce its proper superintendence and maintenance. In one of these the second section of an express train left seventeen minutes after the first one, and after losing eight minutes as compared with the first section, succeeded in running into this in a tunnel. The next day a similar tail-end collision occurred. Even this failed to arouse the vigilance of the French railway employes, for a few days after a passenger noticed at a way station that the employe, one of whose duties is to put out the block signal after the passage of the express train, calmly continued to gum labels on baggage. On being asked why he did not put out the block signal for the express, he replied: "Oh, the express has long legs and can take care of itself!"

The freight service is no better. A trunk took nearly four weeks to come from Bremer-haven to Paris; another the same time to come from Braunschweig to Paris.

The postal service in Paris is wretched. Living within three blocks of a post-office, I get my first mail at nine in the morning. A post-card takes from 10 A. M. to 10 P. M. to go from Rue de Rennes to Rue Spontini. I can walk it in an hour and not hurry. Letters post-marked in Dresden at 5 P. M. Monday are delivered in the heart of Paris at 6.30 P. M Thursday. The railway time between the two cities is 26½ hours; and it must be remembered that 6.30 P. M, in Paris is 7.30 P. M. in Dresden, so that the real elapsed time for the letters is 74½ hours. A letter which was plainly addressed by the typewriter was presented at 6 P. M. to the carrier or porter of a building in which the addressee was boarding. The concierge not knowing the name, and not taking the trouble to inquire if there was a newcomer of that name, refused it, but remembered the name and mentioned it to the boarding house keeper. The guest applied in writing the next morning at the post-office, but although the envelope bore the sender's name and address this letter has never turned up. It has not been returned to the writer, and the post-office authorities write that they regret that all efforts to find it have proved unavailing.

The omnibus service is execrable. These vehicles are rackety, noisy, uncomfortable and dirty. They are too low to permit a tall man to stand upright and too narrow to allow long-legged people to sit comfortably or anyone to keep his feet from being trampled on. The "imperial" or upper deck is difficult for even a man to reach, for a woman almost impossible; and in muddy weather a woman's skirt or a man's overcoat tails cannot be pro-

tected from the mud on the little spiral staircase. The waiting rooms are small and inconvenient. When I add that the principal streets are torn up by the contractors for the underground railway, and that most of them are cluttered up with building material and with carts of dirt or of building material, I am sure that your readers will agree with me that in making their calculations to have their exhibits in place, or even to see the Exposition within a given time, they must not leave these difficulties and delays out of consideration.

I am not urging people to stay away—on the contrary. Those who do not visit the Exposition will miss the grandest sight of a century. But I do urge all to make their arrangements early about board for themselves, and workmen should put their exhibits in place, and commence as early as possible to get things ready—else they will "get left." ROBERT GRIMSHAW.

Grand Hotel du Palais Royal, Paris.

* * *

A TOOL CHEST.

Editor MACHINERY:

The chest described in this letter is especially adapted for machinists when traveling, being light, convenient and strong. The outside is black walnut, polished and oil-finished. This prevents grease marks, as the box can be cleaned by rubbing it with cotton waste and oil. The drawer and partitions are made from black ash and painted black.

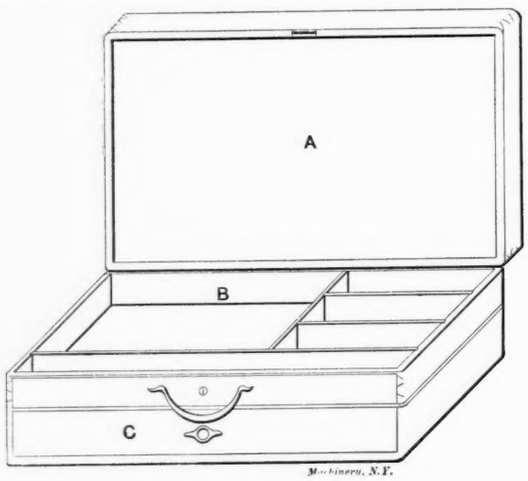


Fig. 1. Handy Tool Chest.

The two accompanying illustrations give a general idea of the box. The outside dimensions are 17" x 10" x 6". The thickness of the outside pieces is ⅜"; the inside pieces are ⅜", 5/16" and ¼". The ends are dovetailed, glued, and strengthened with small screws. The edges are slightly rounded. Fig. 2 illustrates how the partition pieces are joined. They are sunk into the frame or other supports ⅛" and glued.

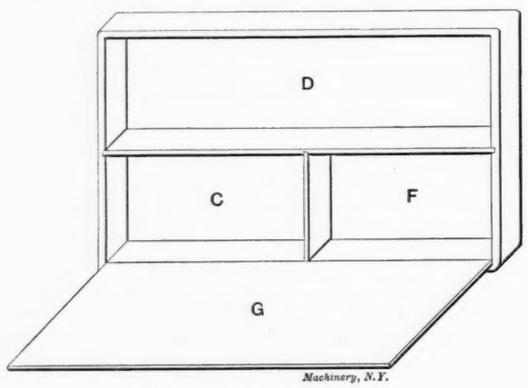


Fig. 2. Arrangement of Tray in Lid.

G in Fig. 2 is the lid for part A in Fig. 1, and it also serves as a writing or drawing board. A is divided into three partitions in which are placed expensive tools, as the micrometer, protractor and 6" square, also several reference books. There is a spring arrangement to lock it with. In Fig. 1, C is a drawer which is intended for heavy tools, such as the hammer, wrench and hack saw. It is divided into two parts by a partition through the center lengthwise. This prevents the heavy tools from crowding and bulging out the sides. It locks by the aid of a small steel rod and spring. To prevent calipers, dividers, scales, etc., from shaking and rattling when traveling, tie them on a big piece of paste-board. The chest when closed resembles a small valise. When traveling it is wrapped in heavy paper and carried by a strap handle. It is easily carried and is saved from rough handling by the baggageman, and also does away with the bother of hiring a truck to get it to the shop.

C. W. SHELLY.

Peterboro, Ont.

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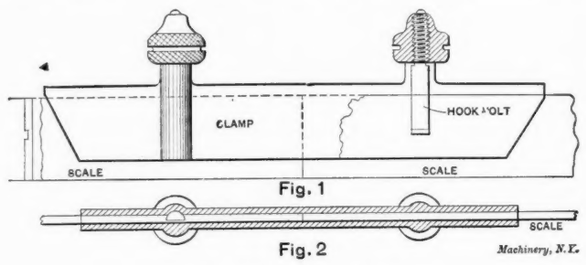
DEVICE FOR HOLDING TWO SCALES FOR LONG MEASUREMENTS.

Editor MACHINERY:

I enclose a sketch of a scale clamp of my own design and also "christened" by me. I have found it very handy when in need of a long scale. It is planed from a piece of cast iron ½" thick by 1" wide by 6" long. The groove is planed to fit the 12" and 18" blades of Starrett's combination square and, with a 12" and 18" scale, the clamp makes a scale 30" long, or with two 18" scales we have one 36" long. The groove is planed with a convex bottom against which the edge of the scale rests. This feature also makes it very easy to true up with a small file to bring the edges of both scales absolutely fair after planing. Most machinists have had use for a long scale at some time or other in their career, and they will find this a very handy device



Device for Holding Scales.

and it will easily go in any machinist's tool chest. The short length of the average machinist's tool chest usually prevents his carrying a scale longer than 18" and the laying of two or more scales on a planer is not always possible or satisfactory. It is, of course, plain that with two of these clamps a scale can be made of almost any length. The space where the two scales butt together is about 1/1000" open, as the light can just be seen through it. This is close enough for all practical purposes. The blades are held by a knurled thumb nut and a half stud to engage the slot in the scale. E. J. B.

Dubuque, Iowa.

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OIL HOLES IN MACHINERY.

Editor MACHINERY:

Why do some tool builders make such poor provision for oiling the parts of machines? Within the last few weeks I had several cases of poorly constructed machines of this kind. One of the machines was a 16 foot boring mill. At the time we had a twenty-ton wheel on and were at work boring it (the rim being finished and the bore nearly so), when a whistling noise was heard coming from below the mill. Investigation proved the trouble to be in the journal near the pinion which meets with the large gear underneath the table. This could not be taken apart without removing the wheel and table, which, of course, I did not wish to do, but the part got so hot within half an hour you could not hold your hand on it, and something had to be done quickly. The oil pipes were flooded with oil and judging from the quantity of oil in the pit underneath this bearing, it was certainly not neglected in this respect. Upon closer examination I found that the oil pipes led to an oil reservoir on the outside of the bearing and a wick leading from this up an inch and one-half into an oil hole, poured oil into the pipes on the outside, and after this small reservoir was filled the oil would run into the pit. This wick would supply oil to the bearing in summer, perhaps,

but not in winter, and after the first few cold days, no more oil reached that journal. So it ran without oil for a while until it got too dry and began to squeak.

We extracted the wick and squirted oil directly into the hole, but all to no purpose; the groove inside had evidently become choked up and would not let the oil in. I was contemplating drilling a few holes in the side of the bearing to admit oil, when it occurred to me that lamp oil or kerosene might cut its way through; so we dosed it with this for a few minutes, and almost directly it stopped squeaking, to our great relief. Immediately after this we oiled up with machine oil, and in an hour the journal had cooled down to its normal temperature.

The aforesaid pipes were nearly horizontal and they soon became clogged up in zero weather. This alone is bad enough without trying to make it climb the wick when really you have to go to the stove to coax the oil out of the end of a squirt can. Some will say the shop where this happens is behind the age. This I must admit, but nevertheless we must generally put up with things as we find them, until we can improve same. The shop that is so cold that every time you want to oil up you are compelled to spend five minutes or more at the stove or heater must necessarily lose from more sources than frozen oil, because the "oil" in the men gets thick, too, and will not flow as it should. You cannot say anything to a man in a shop like this when you find him at the heater. He would not be there if it was comfortable where he ought to be, and the proper thing to do is to make it as comfortable as possible. This, however, cannot be done very readily in some cases, owing to circumstances.

To return to bearings, I would say that I have had a good many machines apart, especially lathes, and have cut larger oil grooves in the cones and back gears and cut them through at both ends to allow the oil to flow out and also any dirt or accumulation there might be in them. After this I have no more trouble. Just this week I had a drill press cone down which stuck fast on its spindle. This had one measly little oil hole in the center of a bearing ten inches long and the oil groove not cut through within ½" of each end. Well, it's not like that now.

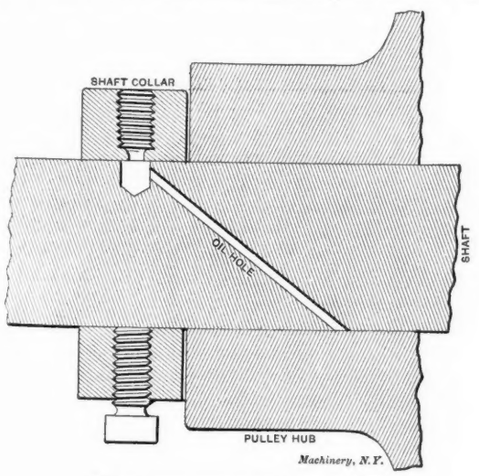
Emsworth, Pa. A. MERTES.

* * *

OILING LOOSE PULLEYS—DEFECTIVE LATHE CONSTRUCTION.

Editor MACHINERY:

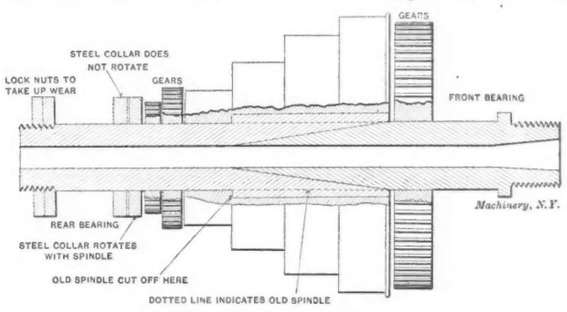
The counter shafts with friction pulleys sent out by many builders have a very poor way for oiling the pulley. The pulley is supposed to run all the time that the engine runs. Some have the oil hole tapped for a cup; some have only a hole. They can only be oiled when the engine stops (and then the oil hole may be on the lower side), or by throwing off a belt. The man



Oiling Arrangement for Loose Pulley.

who does the oiling does not want to put in over time, consequently there is more or less trouble—generally more. I have overcome this by drilling a hole in the collar next to the pulley, some of which I tap and then put in a grease cup. I drill into the shaft a little way, then I take off the collar and drill a small hole diagonally through the shaft, so that the hole comes out near the center of the pulley on the other side. The counter shaft can be oiled any time by just stopping it. I have fixed quite a number this way, and some of them have run 8 or 9 years, and have caused no trouble during that time.

Before the time of hollow spindle lathes every one used a set screw and lock nut to take up the wear caused by the end thrust. This was good enough for that sort of lathe. Then when hollow spindle lathes were put on the market, they still used the same device, with a hollow set screw. Some few builders, I regret to say, use it even today. This is very bad practice. There is always more or less dirt which gets into the hollow and this dirt will work into the rear bearing and cause trouble. One of the lathes in the shop where I am em-



Method of Repairing Lathe Spindle.

ployed came near being ruined in this way. The lathe, in other respects, was in first class condition. I cleaned the boxes and tinned the inside, then babbitted them with genuine babbitt. Before taking down the lathe, I lined it up and made a box like a pillow box to rest on the inside vees. I then pushed the head towards the tail stock and attached it to the carriage, putting the pillow box where the head was. When I put in my bar one end ran on the dead center and the other had a collar next to the pillow box, with a driving pulley on the outside. Then I set the lathe in front of another lathe in which I had an arbor with a pulley on it. In this way I drove the boring bar and obtained the feed by moving the head-stock along the ways by means of the carriage feed.

I next repaired the spindle, the first step being to cut it off between the small cone step and the next larger ones. I took a piece of hollow shaft and chucked it in a lathe that has a taper attachment, and bored out one end taper so that it would reach to the gear and not reduce the spindle at the gear. The shaft was a half inch larger in diameter than the spindle, so I turned the spindle to fit; then pressed the two together and put in several small pins to keep them from working apart. I made a new spindle that reaches clear through the rear box with a device to take up the end thrust, and which will not become clogged with dust or dirt.

If all who have been annoyed as I have been would "kick" against the hollow set screw, I think that all lathe makers would eventually abandon them. W. A. BRIGHT.

Decatur, Ill.

* * *

THE NEED OF PROPORTIONING THE HAMMER TO THE WORK.

Editor MACHINERY:

In going through the average shop, one whose attention happens to be directed to the subject, will be surprised to see how often the wrong tool is used for any given job.

Take for instance, the hammer. A goodly proportion of wielders of this useful tool seem to think a hammer is a hammer, and good to use no matter what kind it may be or on what it is to be used. Now, as a matter of fact, a blow may be struck with any sort of hammer, but there should be some slight consideration paid to the sort of blow adapted to the work. For heavy chipping, riveting, or other work where the work operated upon is rather large, a heavy hammer is generally used, but is it always best to do so? In heavy chipping it is best, because the force of the blow is intended first, to move the chisel, and second to force it into the work, and the hammer should possess sufficient weight to make the force at the chisel edge of the greatest possible effect; but when riveting is to be done, the effect, generally, should be simply to displace or upset the metal near the surface of the rivet.

The heavier the hammer, the more deeply will it affect the ob-

ject struck. This is well understood by forgemen in the large steel plants where steam hammers of great weight are used in order that the effect may penetrate to the center of the piece being forged. This same principle ought to be applied to the use of hand hammers as well, and to a much greater degree than it is. So in the case of heavy chipping, if a light hammer is used, a large percentage of the effect is expended, not in forcing the chisel into the work, but in actually moving the chisel. Inertia, that property of all matter which resists change of motion—which causes a body to resist being started from a state of rest, or being stopped when in motion—causes each particle, of which the chisel is composed, to resist any motion toward the work. While steel is very dense, and so close grained as to be said to have no fibre, it is true that when one end of a chisel is struck by a hammer, it takes a very minute, but measurable length of time for each particle of steel to be moved, one after another, like a wave, from the head of the chisel toward the edge. While this is taking place in the chisel, the opposite effect is taking place in the hammer, and it is being brought to a state of rest. If the force of the blow of the hammer were just sufficient to cause this wave of motion to travel the full length of the chisel and no more, no effect would be produced upon the work, but all the surplus force of the blow over such an amount goes toward useful work, except such very small amount as is lost in heat and friction, and which need not be considered here.

A large hammer has greater inertia than a small one, and consequently at the edge of the chisel there is more force which may be expanded in moving or cutting the metal in front of the chisel. Or it may be roughly said that the large hammer does not stop so quickly as the small one, and during the excess of time required for stopping, the chisel is getting in its work. In riveting, the result desired is quite the opposite of the above, for the rivet is not to be driven bodily through the hole, but simply spread out on the outer end. Here is where the hammer which is light, compared with the work, is to be used. It delivers a sharp blow, the force of which is quickly expanded, being more largely absorbed by—or rather at—the end of the rivet; for as the wave of motion does not penetrate the rivet with such violence, the effect is chiefly upon or near the surface, and the required upsetting occurs.

These effects are so well known to all shop men that it seems strange that so many are contented to own only one hammer of a "handy" size—which means a size easy to swing, and a size that is too small to do much more than batter the end of a chisel on heavy work, and too large, altogether too large, for the numerous light jobs that abound in all shops and in all kinds of work.

FREDERICK M. BUSH.

* * *

WHAT TO DO AND WHERE TO DO IT.

Editor MACHINERY:

I suppose that every machinist, some time in his life, hopes and expects to be the proprietor of a machine shop or manufacturing plant of some kind. The first question is what to make and where to make it?

These questions are very difficult to answer and must, of course, be answered by the intending manufacturer. It is only my idea to give a few suggestions. To begin with, the average machinist has a very limited knowledge of business methods and does not seem to realize the cost of doing business. I have known machinists to declare that the proprietors were making money "hand over fist," when at the same time I was in a position to know that the company was losing every day. Machinists will say, "if the company are losing why don't they shut down?" This, of course, would be the wrong thing to do, as long as there was any hope left, for the trade begins to leave at once and go to other shops that are running. It is a noticeable fact that a customer likes to buy from a busy shop, and, while shut down depreciation and fixed expenses move along with the same regularity. I call attention to these facts for they must be considered after one is in business. There is no escape then, whether they have been previously considered or not.

I would, therefore, suggest that the intending manufacturer secure a position in an office, of his chosen line of business, at any salary. There he could get to see the expense account of the traveling salesman (that would jar him), the bills for advertising, stationery, printed matter, postage and other bills that make up the cost of selling. Then he would begin to realize what it costs to sell goods. Then he might notice a few bills for moulding sand, facing, shovels, riddles, wire brushes, belting, oil, waste, taps, files, twist drills and emery wheels. Then, too, if it happened to be in the fall of the year, there might be a bill there for a new roof and two or three hundred window panes. Sum total these and he would begin to understand the meaning of wear and tear. Then, by going back over the books a short way, he would find where there has been a dividend struck in favor of taxes, insurance, telephone, interest, bad debts and others. These are fixed charges or, at least, they have to be fixed. Then the material bills, taking in everything from pig iron to tacks. He will notice, too, that once, twice or four times a month the timekeeper will hand in a little book that calls for a sum of money on demand, which would take the enthusiasm out of all but the most rugged. This bill can't be put off for sixty days and then settled with a four months' note. Besides there is no discount for cash, but it must be paid for with good cold cash. It must not be forgotten that all of these bills, and more, must be paid for by the goods going out, and, by rights, there should be a little left for the "old man."

After an aspirant has seen some of this side of the business and still thinks he wants to make the attempt, he deserves great credit, and I would not put one stone in his way, and I think he will find the majority willing to help him. If they can't give him anything better they will willingly give what I am now giving, "advice."

Our beginner is supposed to have some means and some reputation in his business and as to character. Without these, the attempt would be useless. He will have to confine himself to some small article, which means small tools for his shop that he could buy with his money and credit. It is not supposed that he would attempt thirty-foot boring mills or suspension bridges, for he might not be able to complete his samples. If he has had experience in die work he would in all probability want to make taps and dies. Unless he has capital enough to equip as well as the present tap and die makers, he had better stay out. If he has, he doesn't have to make them. On this line, I would suggest that he manufacture hand pipe machines to cut 2½" pipe and up, say to 6". There is a fair demand for these machines, and, to my way of thinking, there is not one, of the many on the market, that is made on the right principle. All that I know of turn the die, which is wrong. The pipe should turn to insure good straight threads. Another advantage in turning the pipe is that the cutting-off device can be made more convenient and durable. I think it will be found that the pipe makers and large fitters use the machines that turn the pipe. I see no reason why a small machine cannot be made to turn the pipe, and at a price that would compare with the present small machines. Of course, many will say, "don't make pipe machines, make anything else." If one were proposing to make anything else, the same would be said.

If he has been schooled in engine building he might prefer that line. In this case I would advise keeping out of the small engine trade; but, I do think there are some openings in the larger sizes of high grade. The next move I expect will be made in large engines will be to discard the Corliss valve and adopt the poppet valve and use highly superheated steam. This may sound rank but there is room here for thought.

Then he might understand the machine tool business. In this case if the modern milling machine, with all its improvements and excellent workmanship, is all that it should be, his ideas differ from mine. It never looked just right to me to put a ton or two of metal in a machine with a big overhanging arm, and then put the cutting tool in the center of a long one-inch arbor with a lot of collars on either side. Another idea strikes me that would improve milling machines for some classes of work, and that would be to make the bracket that supports the table removable, something after the style of some shapers, hus allowing work to be bolted to the face of the machine.

Then there are gas engines. For some time past, when a company did not know what to make they would make gas engines. This road looks bright and dark, then gets dark again. Let a beginner start down this pike and he will see the greatest collection of curios known to modern man. He will see and hear

of engines with small bore and long stroke, large bore and short stroke, two cycle and four cycle, vertical, horizontal, tandem and at random; one cylinder and many more, pushing on one wrist or many, all kinds of igniting devices from a tiny spark to a long drawn out flame, like that produced by waving a broom that is on fire; or hot tubes or engines that use none of this stuff, but pack the mixture so tight that it fires itself to get out of misery. He will also see all the different kinds of gears, springs, cams, rollers, pins and pegs that have come to us from ages past. If he has never been down this road he had best not start, as it is lined with fire flies, will o' the wisps, illusions and delusions. But, if he has, he may begin to see that there is an opening for gas engines of the larger sizes. Competition on the small sizes is getting so strong that it stings.

There are, no doubt, good openings in the manufacture of certain mining machines, tools and devices. The glass industry is very large and is far behind other manufacturing enterprises, calling for a great number of improved means and methods, for the production and conveyance of the ware; and especially is this true of the plate-glass branch of the glass industry, this branch being the most brutal, dangerous and laborious manufacturing that I know of. With window glass at its present price I believe that the manufacture of a thin ground glass, made by an up-to-date process, could be made to pay large returns. There is undoubtedly a great field for invention in the glass business, and the manufacturers are alive to the fact now as they never were before.

In the foregoing I have given a few suggestions, but I know that a number of persons will object and say that they are no good. I also know that if you were going to start a mint, some people would object and say that there was no money in that.

Good wages are often a drawback to a good mechanic, as they cause him to hesitate in entering an enterprise for himself. It is also true that there are a number of enterprises that a beginner dare not undertake.

Now, then, where is a good place to start? This depends, of course, largely on what we are going to make. If it sells to farmers, make it in the West; if to millionaires, in New York City; if to cotton growers, in the South, and so on. I know of a fine factory in one of the Massachusetts coast towns that has been for sale for some years, and no takers. Who would want a factory with all of the customers on one side of him. This factory, placed about one thousand miles west, would be an excellent investment, because the raw material would be close at hand and the customers on all four sides. The center of population of the United States lies in southern central Indiana and moves west at about the rate of a mile a year. To manufacture an article of general use, say the pipe machine before mentioned, it would be advisable to locate in the north central states. Ohio, Illinois, Michigan and Wisconsin are the coming manufacturing states. In these nearly all of the raw materials are cheap, living expenses are as low as elsewhere, railroad facilities are good, and the customers are all about. CENTRAL WEST.

* * *

The new shops of the Woodward and Powell Planer Co., Worcester, Mass., are 200 feet long, 85 feet wide, with a gallery on two sides and on one end. The engine room is at one end of the shop, the boiler room on one side of the engine room, and the blacksmith shop on the other side of it, with a spur track running into the building. At the other end there is a basement, which is used for a lavatory and coat room for the men. The foreman's office is on the first floor and on the gallery floor are the main offices, and above the main office the drafting room. This building has a monitor, and therefore there are three banks of windows on each side of the building, which gives a great quantity of light. There is a 10-ton traveling electric crane for handling the product. The work in the gallery is brought to the gallery on one end and is delivered by the crane to the floor.

* * *

An interesting experiment in ascertaining the time it takes to start and stop a steamer, states the "Marine Record," was carried out recently. The Merida, a steamship of 2,309 tons, 260 feet in length, 45 feet beam and with a depth of 21 feet, obtained the maximum speed of 14 miles per hour. The full power of the screw was exerted in stopping the vessel by backing, and from the time it was at full speed until the Merida lay motionless in the water was exactly two minutes.

GAS ENGINE DESIGN.—6.

THE DESIGN OF BALANCE-WEIGHTS AND FLY-WHEELS

E. W. ROBERTS.

Probably the most effective method of balancing the moving parts of any machine is to attach other moving parts to it that are in every respect the same as those which they are required to balance. The best balanced engine is doubtless that in which there are two cylinders of precisely the same size with the pistons and the connecting rods the same in each engine, in both the matter of proportion and of weight. Then if the crankpins are set 180° apart, the engine is probably as perfectly balanced as it is possible to make it. Setting the crank pins of a gas engine with two cylinders at 180° may not appear to be the proper method of distributing the impulses in the most effective manner, because with this arrangement two explosions must follow each other in the same revolution, and the revolution immediately following will necessarily be an idle one. In a four-cycle engine having an enclosed crank chamber and two cylinders, placing the crank pins on the same center will produce a vacuum in the chamber, and experience has proven that the vacuum is productive of annoying consequences. There are, no doubt, some successful two-cylinder engines with enclosed crank chambers which have the crank pins together. The writer has, however, heard considerable discussion on this subject, and the consensus of opinion seems to be that, for best results, the crank pins of such engines should be set at 180°. It is certainly true that some of the most successful automobile engines are balanced in this manner.

Quite a number of gas engines are constructed with single cylinders, and the only feasible way of balancing such engines is to employ a revolving weight, attached either to the crank web or to the fly-wheel. In some engines the weight is cast on the fly-wheel, or a portion of the fly-wheel is cored out at a point on the same side of the shaft as the pin. The best effect, with the least detriment to the engine, is produced by attaching the balance weight to the crank arm, but this position requires a heavier weight than when the weight is at or near the periphery of the fly-wheel, and the cost of construction makes it the more expensive weight to employ. Of the two methods employed, when the balancing is done in the fly-wheel, the core method is perhaps that to be preferred because of its neater appearance.

In order to balance the moving weights on a single cylinder engine, two factors must be taken into account and dealt with differently. In order to balance an engine having a horizontal cylinder for the vertical rocking effect, it is necessary to balance that portion only which may be considered as rotating. For the horizontal effect, the reciprocating weight should be considered, as well as that which is rotating. Thus for the vertical effect it is necessary to consider that effect only which is due to the crank arms, the crank pin and that portion of the connecting-rod which may be considered as rotating. For the horizontal effect, the above portions of the mechanism, that portion of the rod which may be considered as sliding and the weight of the piston must be considered. If, however, the total horizontal effect be balanced by means of a weight, the engine would still be out of balance. A compromise must therefore be made by balancing but half the effect of the reciprocating parts in addition to the rotating parts, although fairly good results may be obtained by balancing the rotating portions alone. The question of speed is thought by some to be an important factor in the balancing of an engine, but it is of no consequence whatever. The true test of a well balanced engine is to shut off all power and allow the engine to slow down of itself without a load, and to see how long it will run before it stops. Other conditions, including those of lubrication etc., being equal, the better the engine is balanced, the longer it will be before it stops. A well balanced engine will, after the gas has been shut off, show no signs of swaying, even if the foundation bolts are loose. To balance an engine intelligently, it is necessary to know the weights of the crank arms, the crank pin and the piston. Should the engine employ a cross-head and a piston rod, the weights of these parts should also be taken into consideration. It is not a difficult matter to calculate the weights of the pin and the arms from the dimensions of the finished crank shaft, but the connecting-rod and the piston should be weighed. The weight of the crank arms should be taken as acting at their center of gravity, while

all other portions of the mechanism should be taken as acting at the center of the crank pin. To find what portion of the rod should be taken as rotating, the rod should be weighed at the larger or crank end while supported on a pivot at the other end.

The plan illustrated in Fig. 24 does away at one time with all computation of the arms, the pin and the rotating portion of the connecting rod. The connecting rod C is put in place on the crank pin and the crank shaft is supported by narrow strips of

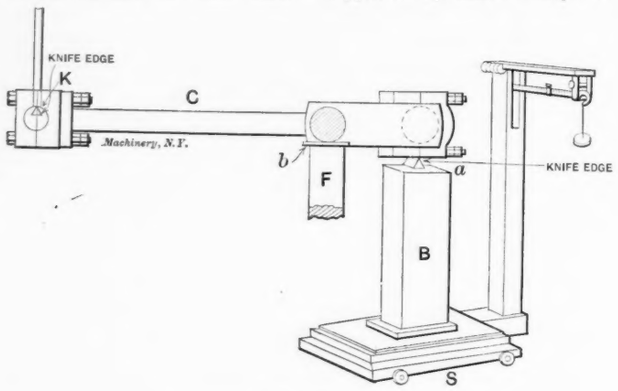


Fig. 24.

metal, one of which appears at b. The piston end of the rod is supported by a knife edge at k, the point of support being directly above the center of the brass. The crank end of the rod, together with the brass, is supported by another knife edge at a, which in turn is supported by the block B resting on the platform of the scale S. The whole is now weighed and the weight of block B, of the knife edge a, and of any other accessories is subtracted from the total. The pieces F which support the strips b must, of course, rest upon the floor and not upon the scale. The axial line of the rod should be horizontal, or nearly so, at the time the weight is taken. This net weight is the amount that should be balanced for vertical effect. In order to get the remaining weight of the rod it may be balanced by another scale at k, with a spring balance perhaps. In case it is inconvenient to perform this operation, 5/8 of the weight of the rod may be taken as rotating, without making a serious error.

The following formulas are those which apply to the two methods in use for calculating the weight of the counter-balance:

Let B = the weight of the counter-balance;
M = the weight of the crank pin = the weight of the rotating portion of the connecting rod;
K = the weight of the reciprocating parts, including the remaining portion of the connecting rod, the piston, and the piston-rod and the crank pin (in engines that employ them);
J = the weight of both crank arms;
m = the crank radius = half the stroke;
j = the distance from the center of gravity of the crank arm to the center of gravity of the crank shaft;
q = the distance from the center of gravity of the balance weight to the center of the crank shaft;

Then $B = \frac{Mm+Jj}{q}$ for balancing the vertical effect alone (35 a);

And $B = \frac{(m M + \frac{K}{2}) + J j}{q}$ for balancing the vertical effect and half that of the reciprocating weight (35 b).

The shape of the balance weight is generally in accord with the fancy of the designer and does not follow an invariable rule. When a portion of the fly-wheel rim is cored out, the method is usually as shown in Fig. 25. Two core prints are made as shown at p p, and the holes may be afterwards plugged up and smoothed over before the filler is applied, so that they will scarcely show through the paint. The design shown at Fig. 26 is a very neat construction, and the method of attaching the weight to the crank arm is very ingenious, in that it avoids drilling holes in the web. The grooves s s are cast in the weight and planed in the arm, and the opening in the weight is slotted out until it is a good fit to the arm. After the weight is in place, the grooves are filled with babbitt metal through the holes hh. While this arrangement may be objected to in that it requires a little more iron than some other forms, it is simple and has at the same time a very neat appearance.

Still another method is shown in Fig. 27. In this design the balance weight is of elliptical form, and is bolted to the arm by means of the wrought iron straps ww and the cap screws gg. When about to place a balance weight on an engine, it is advisable to weigh it carefully in order to see if it comes up to the calculated weight. This will lead to the discovery of any blow-holes that do not make themselves apparent on the surface of the casting. This precaution will save much annoyance and quite often an unnecessary abuse of the designer, when the balance is found to be inadequate. In small engines wherein the room available for the swing of the balance weight is limited, it may be made from lead. The straps ww are cast into the weight.

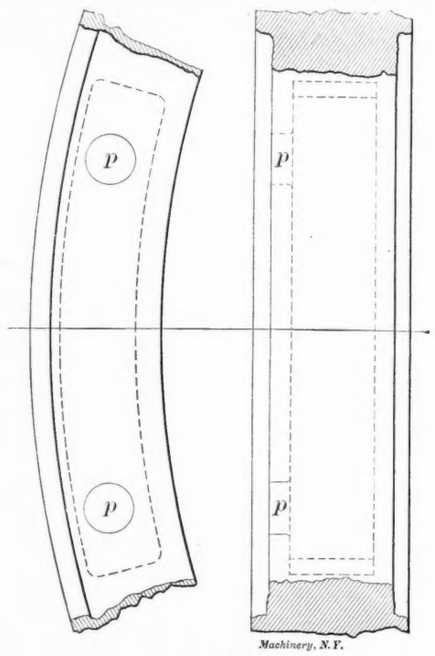


Fig. 25.

The following formula for finding the length of the major axis of an elliptical balance weight is due to Mr. Fred State, for many years a designer with the Dayton Globe Iron Works Co., and is inserted here with his permission:

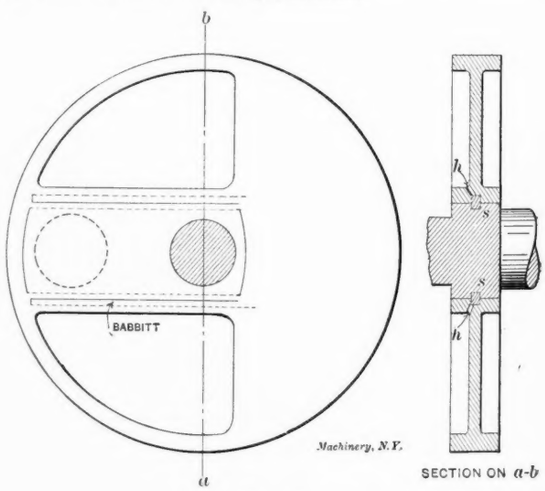


Fig. 26.

Let B = the weight of the balance weight in pounds;
w = the length of the minor axis in inches;
t = the thickness of the weight in inches;
L = the length of the major axis in inches;

Then $L = \frac{4.896\ B}{t\ w.}$ (36)

The application of the above formulas for the design of a balance weight may be shown by the following illustrative example: Suppose that a certain engine has a piston weighing 60 pounds, a connecting rod weighing 40 pounds, a crank pin weighing 6 pounds, and that each crank arm weighs 25 pounds. Let the stroke of the engine be 10 inches, the distance from the center of gravity of the crank arm to the center of the crank shaft 2½ inches, and the distance from the center of the shaft to the center of gravity of the balance weight 4 inches. Formula (35 a) gives the following equation:

$$B = \frac{5\,(25 + 6) + 50 \times 2.5}{4} = 90 \text{ pounds nearly.}$$

As two balance weights are usually employed, the weight of each would be 45 pounds. Note that in the above, ⅝ of the

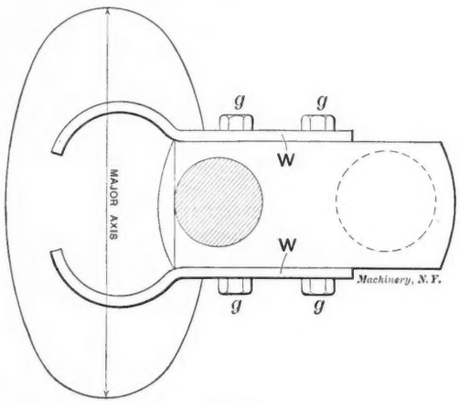


Fig. 27.

weight of the connecting rod has been considered as rotating. Applying formula (35 b), the equation becomes:

$$B = \frac{5\left(6 + 25 + \frac{60 \times 15}{2}\right) + 50 \times 2.5}{4} = 114 \text{ pounds nearly.}$$

and the weight of one balance weight will be 57 pounds. The above example should not be considered as showing the difference in results that would be obtained in the use of the above formulas in actual practice, for the reason that the writer has chosen the weights of the various parts at random, and not from actual data.

Taking the formula for an elliptical balance weight, and assuming the thickness of the weight to be 2¼ inches and the minor axis to be 7 inches, formula (36) becomes, with B =45 pounds:

$$L = \frac{4.896 \times 45}{2.25 \times 7} = 14 \text{ inches nearly.}$$

If the writer's experience will count for anything, the fly-wheel is as little understood as any part of the engine, and the formulas for its design which have been published seem to add to the confusion. Why this is so I will leave to the reader to determine, for many of these formulas are excellent and give good results in practice. The most confusing thing about them is that they leave the designer in the dark about the co-efficient to be employed for engines designed for the different classes of work. The writer has computed the co-efficients employed by some of the most successful designers and finds that they agree very closely with those given by Professor Unwin in his admirable work on "Machine Design." In calculating the weight of the fly-wheel, the effect of the fly-wheel arms is not considered and the effective weight is taken as that in the rim of the wheel. For the calculation of this weight it is perhaps the more correct method to lay out a diagram showing the effect of the impulse upon the crank pin and also the effect of the moving parts at the various portions of the stroke. For the requirements of the drafting room these refinements are, in the writer's opinion, scarcely necessary, for the reason that once a basic formula is found, the construction of the diagrams will be found to bring about a result that differs but little from the result obtained by the use of the formula. The following formula for a four-cycle engine appears to give results which are sanctioned by good practice:

Let W = the weight of the fly-wheel rim in pounds;
f = the diameter of the fly-wheel at the center of gravity of the rim, in inches;
N = the r. p. m. of the crank shaft;
E = the co-efficient of unsteadiness permissible;

Then $$W = \frac{\text{I. H. P.} \times 111{,}600{,}000}{f^2 N^3 E} \quad (37)$$ when an impulse occurs at every fourth stroke. If the I. H. P. (indicated horse power) is that of the engine when exploding less frequently, the value of the figure in the numerator must be increased in proportion. It is well, however, to compute the weight of the fly-wheel for the maximum power of the engine. If the power is taken as that when the engine is exploding at every eighth stroke, as with a hit-and-miss governor at half power, the weight found by the above formula should be doubled. As the power is half that of the engine, the operation brings the weight to the same as that when computed at full power. If the engine is controlled by a governor that reduces the strength of the impulse without cutting out any impulses, the computation should, for powers less than the full power of the engine, be made by the use of the above formula as it stands.

The following are the values of E as given by Professor Unwin, with the addition of a constant for marine practice which the writer has deduced from tables in his possession.

For marine engines	.15
For pumping water and all ordinary requirements..	.05
For driving machine tools	.03
For driving textile machinery	.025
For driving dynamos	.02
For driving spinning machinery	.01

Quite frequently the use of a very heavy fly-wheel on the crank shaft of the engine is avoided by employing a fly-wheel on a jack shaft, on the armature shaft of the dynamo, or on both, when the engine is used for dynamo driving. As the weight of the fly-wheel is in inverse proportion to the square of its diameter at the center of gravity and to the cube of the r. p. m., any increase in the diameter of the wheel or in the speed of the engine will make a marked difference in the weight of the fly-wheel required. The writer knows of at least one manufacturer

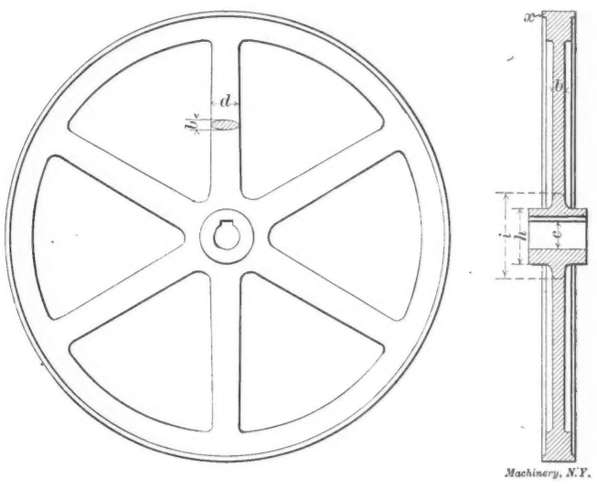


Fig. 28.

who runs his engines at an increase of speed over that employed for ordinary purposes, when the engine is to be employed for driving a dynamo. The speed of the "electric light" engine is made nearly double that of the same engine when used for ordinary purposes. A double advantage is gained by this increase in speed. The fly-wheel is not only reduced in weight, but the power of the engine is increased in a direct ratio with the speed and a much lighter engine may be built for the same service. In spite of the many assertions to the contrary, the limit of speed in the gas engine has by no means been reached, and it is steadily advancing with improved methods of construction and design. The writer knows of a large engine now under way in the shops of a prominent manufacturer, which is designed to run at a piston speed of 1,000 feet per minute.

The diameter of the fly-wheel is usually from four to five times the stroke of the engine. It is seldom that the latter ratio is

exceeded. The limit of peripheral speed is given by good authorities as 6,000 feet per minute. The following formula for the limit of speed is that given in Kent's Mechanical Engineers' Pocket-Book:

Let D = the outside diameter of the fly-wheel in feet;
N = the r. p. m.;

$$\text{Then } D = \frac{1910}{N} \qquad (38).$$

The general proportions of the fly-wheel may be shown by the aid of Fig. 28. The general proportions of the rim are omitted, as they depend to a great extent upon the weight required in each particular case.

Let c = the diameter of the crank shaft.;
Then h = 2c;
i = 3c;
d = .8c to 1.2c;
b = .4d (39)

It appears to be quite the universal practice to employ six spokes for the fly-wheel of a gas engine, although in very large engines eight and even ten spokes may occasionally be found. The arms are given a slight taper of from ¼ to ⅜ inches per foot of length, the dimensions d and b being those at the middle of its length. The length of the hub should be at least 1.5 times the diameter of the shaft, the average ratio being 2c and in some cases it is as high as 2.5c.

In order to show the application of these formulas, the writer will compute the dimensions of a fly-wheel for a fifty horse-power single-cylinder four-cycle engine. With a mechanical efficiency of 80%, the I. H. P. of this engine would be 63 horse-power. The dimensions of the engine would be 16" x 24" with a speed of 150 r. p. m. Assuming the outside diameter of the fly-wheel as four times the stroke, it should be 96 inches, or 8 feet. Assume that the depth of the rim section will be 6 inches, and the center of gravity of the rim section would be 3 inches from the outside of the wheel,* giving the diameter of the center of gravity as 90 inches. A preliminary calculation for the weight of the rim may now be made and the depth may be changed if it be found that the rim will be either too wide or too narrow. Taking as the co-efficient that for ordinary requirements, the equation according to formula (38) becomes:

$$W = \frac{63 \times 111{,}600{,}000{,}000}{90^2 \times (150)^3 \times .05} = 5{,}144 \text{ pounds, call it } 5{,}140 \text{ pounds.}$$

As there are to be two fly-wheels, it is necessary to divide this result by two in order to get the weight of one wheel. The weight of one wheel would then be 2,570 pounds in the rim. In computing the dimensions of the rim, the weight of cast iron may be taken .26 pound per cubic inch. Dividing the weight by .26 the volume of the rim will be 2,570 ÷ .26 = 9,885 cubic inches. The mean diameter of the rim section has already been taken as 90 inches, and the circumference at this point would be 282.7 inches. Dividing the volume by the circumference, 9,885 ÷ 282.7 = 35 square inches for the area of the rim section. As the depth of the rim has been taken as 6 inches, this would give a width for the rim of 5.83, say 5¾ inches.

Since there is usually a flare at the periphery of the wheel as shown at X, the body of the rim may be taken at 5½ inches wide and the extra ¼ inch put into the widened portion. Making the depth of the flare 1 inch, the added width must be six times ¼ or 1½ inches, which will give ¾ inch on each side, and the total width of the rim at the outside will be 7 inches. The reader should note that this is a much lighter fiy-wheel than is used for driving manufacturing machinery, and that it is only suitable for an engine which is pumping water or driving machinery in which steady speed is of little consequence.

For the proportions of the hub and the spokes, taking 6¼ inches as the diameter of the crank shaft, the diameter (h) of the hub will be 12½ inches, i is 3c or 18¾ inches, and d may be taken as equal to c or 6¼ inches. Applying formula (39) to find b, we have

$$b = .4 \times 6.25 = 2.5 \text{ inches, nearly.}$$

The length of the hub will be 12 ½ inches, or twice the diameter of the crank shaft. The arm is nearly always made of an elliptical cross-section as is indicated in the figure. The writer has followed the proportions given by the above results in the design of the fly-wheel shown in Fig. 26.

Errata.—In formulas (26a), (26b) and (26c), article No. 5 of this series, which appeared in the April issue, the index has been omitted from the radical sign. The error makes it appear that the square root of m should be taken while the fourth root is that intended.

E. W. R.

* * *

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

If the subscriber in Kentucky who asks about lathe speeds will send us his name and address, we will reply to his inquiry.

53.—R. C. G. desires to make a burner for vaporizing and burning kerosene with a blue flame. He has tried running a pipe from the tank and so bending the pipe that the burning vapor from a row of holes in the pipe heats the oil in a part of the pipe above the flame and vaporizes it ready for burning. He complains, however, that he does not secure a hot enough flame for his purpose. Possibly some reader can suggest proportions for a burner of this type.

54.—We submit the following questions to our subscribers: 1. What is the best method of browning and blueing steel to prevent it from rusting. The steel is occasionally subjected to wet weather, as for example, in the case of gun barrels. 2. A cement for fastening leather to cast iron. The enquirer has tried fish glue, but does not find it satisfactory. He wishes to cover friction pulleys with leather, and although he allows for stretching and rivets the leather on the pulley in places, it troubles by pulling off.

55.—H. V. D.: In a number of mechanical engineers' reference books I find the thickness or depth of the heads of U. S. Standard bolts given 1/16th inch less than the diameter of the bolt in each case, and in a number of other books the depth is given as ¾ the diameter of the bolt plus 1/16th inch, which gives a thinner head than by the other formula. I also find each of these referred to as the U. S. Standard, the Franklin Institute Standard and the Sellers Standard. Can you tell me which of the two proportions is correct for bolt heads and what variation there is, if any, in the standards of the United States, of Franklin Institute and of Sellers?

A.—Our understanding of the questions is as follows: In 1864 William Sellers read a paper before the Franklin Institute of Philadelphia upon a "System of Screw-threads and Nuts" which gave the results of his experience. In the same year a committee of the Franklin Institute recommended the adoption by that institution of the Sellers system, which was done. At this time bar iron and steel were not made in the variety of sizes that can now be obtained, and it was thought best to adopt sizes for finished bolt heads and nuts 1/16 inch smaller than the rough heads and nuts. Accordingly, the distance across flats for rough heads and nuts was made 1½ times the diameter plus ⅛ inch and for finished bolts and nuts, 1/16" smaller. The same plan was followed with regard to the depth or thickness of heads and nuts, and both heads and nuts were made equal to the diameter of the bolt in depth for rough bolts and 1/16" less for finished. Later, the Sellers system of screw threads was adopted as standard by the army and navy departments of the United States government, but changes were made in the proportions of the heads and nuts. The distances across flats was made equal to 1½ times the diameter of bolt, plus ⅛ inch, for both rough and finished bolts; the depth of the nut was made equal to the diameter of the bolt for both rough and finished stock, and the depth or thickness of the head was changed to ¾ diameter of bolt plus 1/16 inch for both rough and finished. Thus, in making bolts and nuts to conform to the United States standard, stock must be used that is a little oversize, if they are to be finished, and the heads will be thinner than called for by the Sellers standard.

* Although the center of gravity of a ring lies a short distance outside of the line midway between its inner and outer circumference, the assumption made does not involve an error of consequence.

56.—In the April number we submitted two questions to our subscribers. One was about fusible solder to solder babbitt letters to cast iron. A contributor who wishes to go by the name of "S. Wrench" says in regard to this: "These letters are seldom made of babbitt, but of white metal, which fuses easily when touched with a very hot iron, and it is difficult to do a neat job with it. First file the casting bright, and then tin with zinc chloride and use the following composition for a fusible solder: Tin 3 parts, lead 4 parts and bismuth 2 parts, using zinc chloride as a flux. Or, if preferred, I can send a recipe for cold soldering.

"In my practice I find the easiest and best way to attach such letters to cast iron patterns is to fasten them in position with wax and then drill and pin them with brass wire."

The other question that we submitted asked for a solution for coloring bright brass a fast dull black. To this our correspondent who replied to the first question says that platinum chloride rubbed in with the hand and then washed and polished with oil and leather is about the best process, but lamp black and shellac, mixed thin, make a good surface where the article does not have to be handled.

A. E. Whiting, Ashtabula, O., and a subscriber at Ottawa, Can., both recommend another recipe, which Mr. Whiting says is used by French instrument makers. The metal should be dipped in a mixture of equal parts of the following solutions:

No. 1.	Silver Nitrate	40 grains.
	Water	100 minims.
No. 2.	Copper Nitrate	40 grains.
	Water	100 minims.

When removed from this solution it should be allowed to dry and then should be uniformly and gradually heated until it assumes the desired black.

57.—F. F.: To settle a dispute, please define lead and pitch, as used in connection with a screw. It is agreed by all that with single-threaded screws the terms are synonymous, but there is a difference of opinion when it comes to multiple-threaded screws. Do lead and pitch both mean the same thing in this case, or does one refer to the longitudinal distance from thread to thread and the other to the distance that the screw would advance in one turn, and if so to which term should the latter definition be given?

A.—Lead invariably means the distance that the screw would advance in one turn. The term "lead" means to guide, or help along, and in the case of a lathe lead screw, for example, the lead is the distance that the carriage is helped or moved along in one turn of the screw. This definition would hold whether the screw were single—or multiple-threaded. With regard to the term "pitch," different dictionaries define it differently, but the new Standard dictionary says it is "the amount of the advance of a screw thread in a single turn." According to this the term is synonymous with lead, and we believe it is almost universally the custom to so consider it.

58.—A subscriber wants to know how to calculate the weight of a fly-wheel for a gasolene engine for driving an automobile. He thinks the wheels used for stationary practice are too heavy, since the inertia of the carriage should act in a measure to help the engine just as a fly-wheel would help it.

A.—We referred this question to Mr. Arthur Herschmann, New York, who replies as follows: "He should not rely on the inertia of the wagon, and if he is not careful it will do him more harm than good. When this inertia is most wanted, the wagon is at rest, that is when stalled on a dirty road or when ascending a hill.

"In such cases nothing but a very heavy fly-wheel will do the business. I had many a sad experience before I found this out, and the clutch which you must throw in when starting the wagon can be less carefully operated when the fly-wheel is heavy. The wagon will "buck" like a horse, and the fly-wheel will do what much more powerful engines would probably fail to do.

"Weight of fly-wheel in tons should equal I. H. P. × 14,109,209 ÷ square diameter in feet × cube of highest speed. Thus, say we have a 10 H. P. engine, maximum number revolutions 600. Fly-wheel two feet diameter. Then

$$\frac{10 \times 14{,}109{,}209}{4 \times 216{,}000{,}000} = 0.163 \text{ tons} = 326 \text{ pounds.}$$

"Probably I should take chances, even on a single cylinder machine, and make the wheel much lighter. Twin cylinder engines are almost universally employed and call, of course, for a lighter wheel, and to an extent according to the way you couple up. If the cylinders are side by side and act on the same crank the engine will be out of balance, but there will be only one idle stroke between each explosion. If there are two cylinders side by side, acting on separate cranks at an angle of 180 degrees, there will be alternately two power strokes and two idle strokes. If with the same arrangement of cranks the cylinders are placed opposite to each other, there will be alternately an idle and an explosion stroke, and the engine will be in balance."

59.—Reader: Will you kindly give me some information regarding the propeller for a small launch. We have a boat 20 feet long and 5 feet wide, drawing about 22 inches of water. The power is a gas engine 4½" x 5". We use a reversible blade propeller, 13 inches in diameter, but it is too small, the engine running up as high as 600 revolutions per minute, making the engine so hot that it explodes of its own heat, often back-firing. What size screw would hold it down to about 400 revolutions per minute? Suppose we should take the same blades we have, and put them on a hub of larger diameter, would it answer as well as a larger blade on an old hub? Would three blades be more effective than two blades? 2. Can you give me any information on the jump-spark method of gas engine ignition? Is it effective? Why is it not more used by gas engine makers?

A.—No mention is made of the class of engine, whether it is a two- or a four-cycle. If a two-cycle engine, as we presume it is, use a 16" 3-blade propeller or an 18" 2-blade. The advantage of a 3-blade propeller is that it will start the boat more quickly and is more effective when towing than the 2-blade. It often happens that a boat with 4-bladed screw will lose two opposite blades without any noticeable difference in its behavior after the vessel is under way. Very often a 2-bladed propeller is speedier than either a 3- or a 4-bladed screw. We do not advise making the change you suggest, but suggest trying a larger screw.

2. The jump spark method has been brought into favor since the advent of the automobile. It is the most effective method of igniting gas engines running at high speeds. It is considered by many to be the most up-to-date method of igniting, and it will probably find favor with builders of the slower speed engines as soon as they find out how to master the difficulties that accompany its use. One piece of pertinent advice we would offer the experimenter with the jump-spark, is not to attempt to build your own coil, but buy it of a maker who has the necessary experience and skill at his command. Insulate both electrodes and make the surface of insulating material (that it is necessary for the carbon to bridge across before making a short circuit) as large as the space will permit. Use about a half-inch spark coil and place the terminals so that the air-gap between them is not over ⅛ inch. This will make the spark a hot one and strong enough to prevent bridging between the terminals. It should be remembered that it is more difficult to insulate for the high voltage necessary with this spark and that the best materials and the best of care in their manipulation should be used when insulating the ignition plug. Mica and porcelain are good insulators, while asbestos is practically useless. The porcelain should be glazed. If it is intended to dispense with the vibrator and to use the induction of a single make and break in the primary for the spark, it should be remembered that the spark produced when the primary circuit is broken is much stronger than that when it is closed, and only this spark should be depended upon for ignition. If the engine is to run at a high speed, so design the switch that it will keep the circuit closed long enough to establish the necessary amount of magnetism in the core of the coil. If the spark proves to be a weak one, and other conditions are right, look to the switch for your trouble. When purchasing a coil, buy one that has been designed for the purpose and not one of the variety sold at toy stores. There are several on the market built expressly for gas engine ignition.

E. W. Roberts.

60.—S. T. W.: Will you kindly give me the formulas for the following problems: 1. Two weights of 10 pounds each are hung, one on each end of a straight lever 6 feet long, the lever weighing 5 pounds. The lever thus weighted balances at a point three inches from the center. Find its center of gravity. 2. In a lever of the third class 10 feet long a force of 50 pounds 6 feet from the fulcrum balances a weight of 25 pounds 10 feet from

the fulcrum. What is the weight of the lever? 3. If a body is thrown upward with a velocity of 644 feet per second, what will be its velocity at the end of 28 seconds and in what direction?

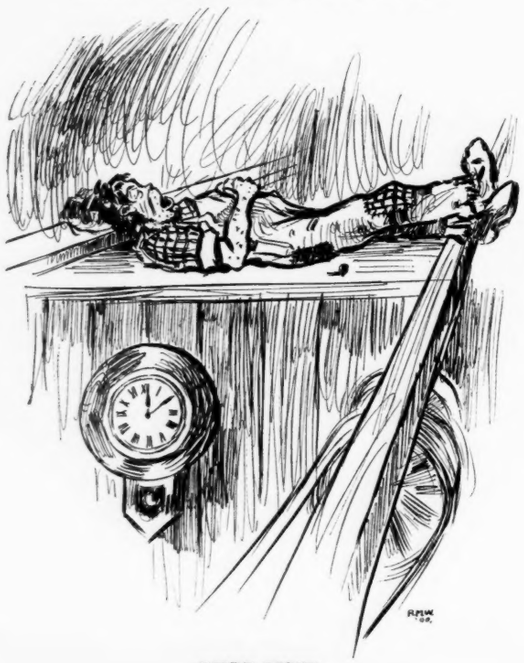
A.—Questions of this description are easily answered by the aid of the formulas contained in any manual of elementary mechanics. The first two are taken from several relating to levers that S. T. W. has sent us and these have been selected as representative of the whole. All lever problems are easily solved by the principle of moments which is that the forces tending to turn a body in one direction about a pivot times the perpendicular distances from the pivot to the lines of directions of these forces must equal the products of the forces tending to turn the body in the opposite direction and their perpendicular distances from the pivot. Applying this to the first question, we have: 1. Forces tending to turn the lever in a left-hand direction about the fulcrum are a weight of 10 pounds and the weight of the lever, which a little consideration will show must act at the left of the fulcrum to balance the lever and weights. The only force tending to right-hand rotation is the right-hand weight of 10 pounds. Let x be the distance in inches from the center of gravity, at which the weight of the lever acts, to the fulcrum. Taking into account the distances at which the other forces act, we get the equation, $10 \times 33 + 5x = 10 \times 39$, or $330 + 5x = 390$ and $5x = 60$, x 12 inches. 2. In the second example the dimensions can be taken in feet, since there are no odd inches to be considered. Assuming that the center of gravity of the lever comes at its center and placing opposing moments equal to each other, $50 \times 6 = 25 \times 10 + 5W$, where W equals weight of lever, $5W = 50$, $W = 10$ pounds. 3. Since the retarding effect of gravity is at the rate of 32.2 feet per second, for each second, a body starting upward with a velocity of 644 feet per second would come to a stop and start downward again at the end of $644 \div 32.2 = 20$ seconds. It would then have 8 seconds in which to fall and in that time it would acquire a velocity of $8 \times 32.2 = 257.6$ feet per second.

61.—F. G.: What book will give the most information on batteries? 2. How can I magnetize a permanent horseshoe magnet? 3.—How can hard rubber be turned and polished in a lathe?

A.—Carhart's Primary Batteries. Price, $1.50. 2.—The best way to make a strong permanent magnet is to wind around each leg several thousand turns of fine magnet wire, and then pass a current obtained from half a dozen battery cells through the coil for two or three seconds. The wire on the two legs must be so connected that if the bar were straightened out both coils would be wound in the same direction. 3.—Turn in a fast running lathe, the higher the speed the better. Use a sharp tool, sharpened on a fine oil stone, and polish with a piece of felt or flannel; or better yet, use a diamond for cutting.

* * *

SHOP TERMS ILLUSTRATED.



OVER-TIME.

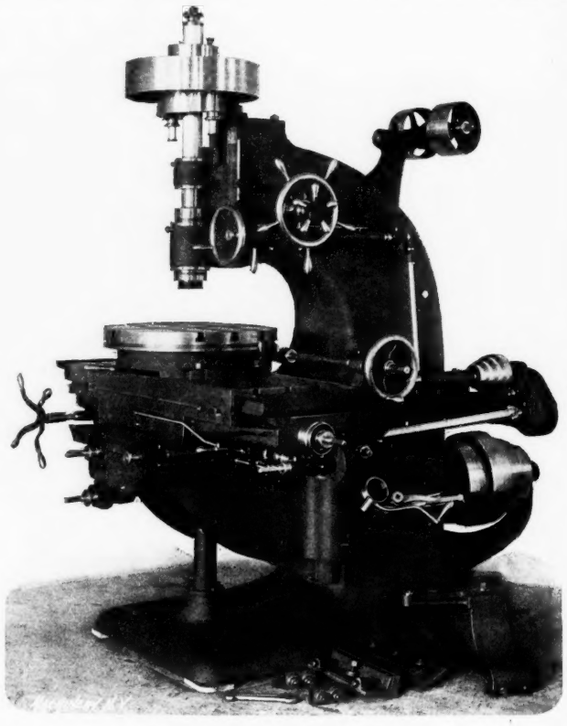
NEW TOOLS OF THE MONTH.

Under this heading are listed the new machine and small tools that have been brought out during the preceding month. Manufacturers are requested to send brief descriptions of their new tools as they appear, for use in this column.

NEW BECKER-BRAINARD MILLING MACHINE.

The accompanying half-tone shows a new vertical milling machine recently brought out by the Becker-Brainard Milling Machine Company, Hyde Park, Mass. This machine is known as No. 5B, being an intermediate size between the regular No. 5 and No. 6, and is considered as the best size for most shops, as it is neither too heavy nor too light to meet the requirements of the average shop.

The general usefulness of the vertical milling machine is being emphasized more and more from year to year as users of these tools learn to appreciate their peculiar advantages. The useful end-mill can be used to far greater advantage with a vertical spindle than on one that is horizontal, since the work is better supported in this position than is usually possible with the horizontal machine, and the operator can better follow it with his



Becker Milling Machine, No. 5 B.

eye. Another advantage possessed by the vertical milling machine is the facility with which it lends itself to profiling or milling irregular slots in the face of a piece. Face milling is also performed under advantageous circumstances, as the favoring conditions are the same as those referred to when end milling.

Some of the peculiar features which mark the Becker milling machine are that the work spindle is entirely relieved of the pull of the belt, the pulley being supported by a supplementary bearing which relieves the spindle of all strain except the torsional stress necessary for driving the cut. On heavy cuts it is, of course, necessary to increase the turning moment and decrease the speed of rotation, which is accomplished with back gears, but in order to equalize the driving stress and prevent side action, the back gears are applied in duplicate on opposite sides of the vertical spindle. The bearings of the spindle are bronze bushings fitted in taper holes and split on one side so that adjustment is effected by longitudinal movement of the bushings relative to the frame. The spindle is bored to the Brown & Sharpe No. 11 taper and the milling cutters are secured by a draw-bar through the spindle, which can be seen projecting from the upper end.

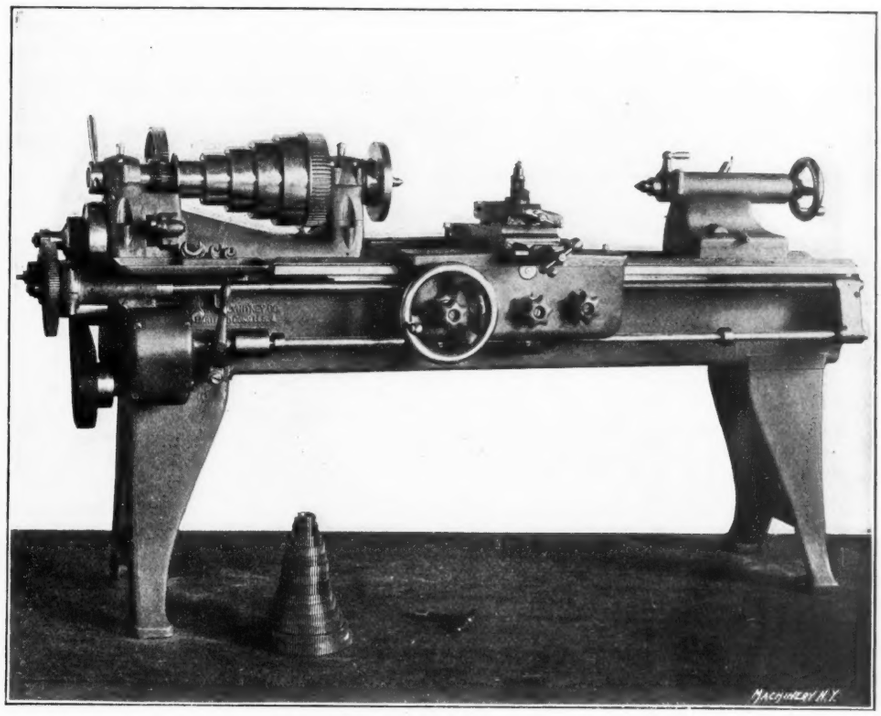
The head carrying the spindle has a vertical travel of 9″, which may be either automatic or by hand. An automatic stop is provided which will throw out the vertical feed at any point, an essential feature in vertical boring. The platen is 51½″ long by

14″ wide and has an automatic feed of 42″ in either direction. The saddle carrying the platen is of the same length as the platen and also has an automatic feed of 16″ in both directions. The knee supporting the saddle and platen has automatic feed.

The machine is supplied with a rotary table 22″ in diameter having automatic feed in either direction. The extreme distance between the spindle and rotary table is 16″ and between the spindle and platen without rotary table, 21″. The tables have eight feed changes for any spindle speed and the rotary table has sixteen changes which enable a close approximation to be maintained for the various peripheral speeds of the rotating work, which occur on account of different distances from the center of rotation of the work table. Thus a certain angular velocity might give the correct feed for a piece being machined at a point 6″ from the center of the rotary table, but the angular velocity would necessarily be only one-half as great for the same feed as a radius of 12″.

For supporting long and slender cutters, an arbor support is provided which is attached to the knee and used with the rotary table removed.

The machine is provided with an automatic oil pump and connections and a two-speed countershaft which has a ratio between the two speeds of 4 to 1, thus enabling a wide range of speed to be obtained without shifting the belt on the cone pulley. We are informed that the net weight of the machine is 4,560 pounds.



A Heavy 14-inch Lathe of New Design.

PRATT & WHITNEY MANUFACTURING LATHE.

The lathe shown in the cut herewith, is of improved design, having a number of mechanical features which commend it for manufacturing purposes. The aim has been to incorporate in it only features of practical value and to simplify the construction wherever possible. The bed is made of a tubular cross-section which is well calculated to resist torsional stress. A comparatively new feature in American practice is the employment of flat and V-ways, by which construction considerable gain in strength to the carriage is obtained together with an absence of the tendency to cramp, as is quite noted where two vees are used. The ways for the carriage consist of one vee in front and a flat way at the back, while the arrangement for the tail-stock is reversed, the flat way being in front and the V-way at the back. By this combination, cutting away of the carriage, at the point where the most strength is needed to resist the pressure on the tool, is avoided.

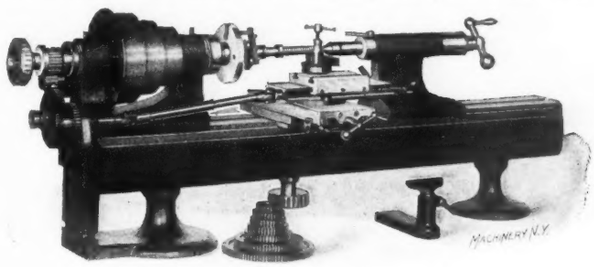
The spindle is made from high grade steel with the bearings accurately ground and fitted to babbitt bearings. It has a 1.3″ hole through it and has a bearing 2 7-16″ x 4″ in the front box. The carriage is gibbed front and back and the apron is made double, so that the shafts supporting the feed gearing are all supported at both ends. For turning, a feed rod is provided, driven by a two-speed cone. The belt driving it is broad and an idler is provided for taking up the slack, thus providing means for increasing the tension when necessary and doing away with the continual cutting and relacing of the feed belt. Both longitudinal and cross feeds are operated by friction clutches and worm gearing. The worms are hardened and run continually in oil. Automatic feed stops are provided for the longitudinal movement of the carriage. For screw cutting, an independent screw is provided which, with the gearing provided, will cut all ordinary threads from 2 to 92, including 11½. Translating gears are provided for cutting metric threads with the English lead screw or a metric lead screw can be had, also with translating gears, by which ordinary threads from 2 to 22 can be cut, including 11½.

A taper attachment is provided which can be attached to the cross-slide by clamping one bolt. The taper attachment does not involve the use of any extra working joints, the construction being such that the working joint of the cross-slide answers for both functions. Although the machine is nominally rated as of 14″ capacity, its actual capacity is 15⅞″. The tail-stock is of the English form which allows the setting of the compound rest parallel with the ways without interference on short work. The lathe is furnished either with or without compound rest or the taper attachment. The usual equipment of wrenches, face-plates, change gears, steady and follow-rests, etc., is provided. This lathe is built and sold by the Pratt & Whitney Co., Hartford, Conn., or 123 Liberty street, New York.

A BENCH LATHE AND MILLING MACHINE.

The accompanying engravings show the Waltham Watch Tool Co.'s No. 5 bench lathe arranged for turning and also for milling. The success of the No. 1 universal lathe has induced the company to meet the demand for a larger bench lathe made on the same lines and also provided with the Van Norman milling attachment.

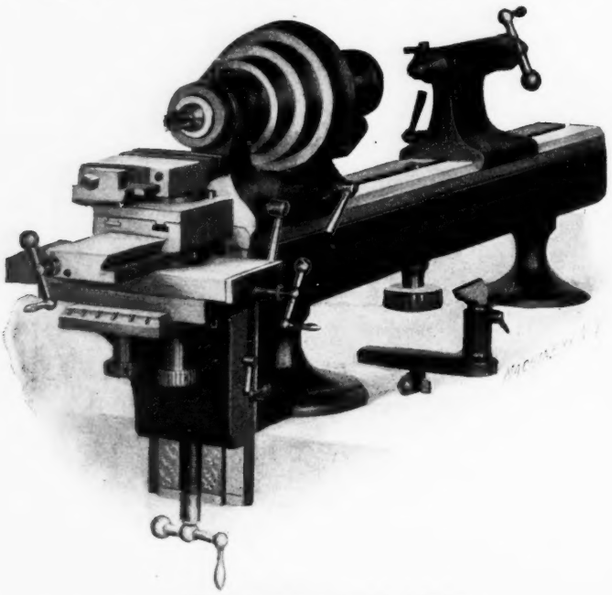
The lathe illustrated has a 38″ bed and 9″ swing. The spindle is accurately made, being hardened and ground, and is made hollow throughout for the use of draw chucks. The chucks used on this lathe are made interchangeable with those for the Van Norman duplex milling machine. A full line of attachments is provided, so that screw-cutting, grinding, drilling, milling, etc., can be done, thus making a combination machine of wide application. The screw-cutting attachment has a capacity of 6″ and a screw of this length can be cut at any point along the bed within the extreme capacity of the centers.



Nine-inch Bench Lathe.

To use the milling attachment it is necessary to reverse the head-stock, which can be done very quickly. An upright angle

slide is bolted to the vertical web, shown at the end of the frame, and the slide-rest is fastened on top, either in the position shown or turned around so that the cross-slide handle will come on the back. The slide-rest can also be mounted from the end, thus giving it three distinct positions. It will be noted that the slide-rest is so made that the addition of the swivel base milling vise completes the milling attachment. For index milling an index head is provided with a hollow spindle adapted to take in the

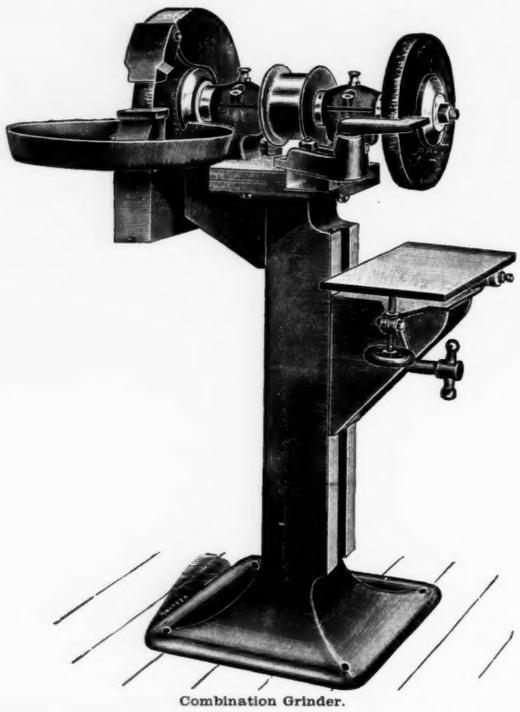


Milling Attachment for 9-inch Lathe.

regular split chucks used in the spindle. The vertical movement of the knee is 6", which, together with the 6" movement of the slides, gives the machine a considerable capacity and well adapts it to a large variety of model work, tool making, experimental and precision work of all kinds. It is manufactured by the Waltham Watch Tool Co., Springfield, Mass.

TOOL AND SURFACE GRINDER.

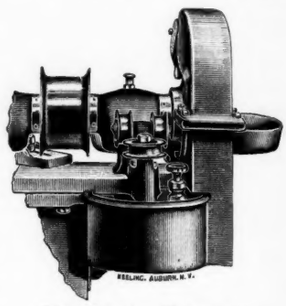
The illustration shows a simple and complete water tool grinder and dry tool and surface grinder in one machine, having



Combination Grinder.

a number of distinct advantages. The wheels carried are 14" x 2", the intention being to provide a machine suitable for general use in the ordinary machine shop. The weight of the machine (650 lbs. with counter-shaft) and the diameter and length of the bearings, together with their self-lubricating properties, insure rigidity and steadiness of the entire machine and dispose effectually of the usual argument against a tool carrying two wheels.

The arrangement of the water-pan and water-feed is such as to prevent spattering and to do away entirely with disagreeable features of the ordinary wet grinder. The operator has no pedal on which he must stand while at work, but is free to move about the wheel as he pleases. There is no rack, pinion, float, or other device for controlling or feeding the water, and it is utterly impossible for the wheel to stand in water to soften and spoil when not in use. The ordinary objections to a pump on a grinding machine do not apply to this tool, as the wearing surfaces of the pump bearings are at all times entirely above water. The unsightly pipe and valve which appear on many grinders directly over the wheel are entirely done away with in this machine, and the construction is such that the entire water-pan and water-way are easily and perfectly accessible when it becomes necessary to clean out the sediment.



View Showing Water Pump.

The importance of a surface grinder is growing in recognition in machine shops, and the arrangement of this machine is such that all ordinary surfacing work can be readily performed without interfering in any way with the water wheel.

The makers call special attention to the spindle and spindle bearings in this tool. The actual diameter of spindles in bearings is 1½" and each bearing is 6" in length.

Each bearing is provided with a sleeve of the best babbitt metal, this sleeve being bored, reamed and turned, and threaded on each end, the threads being right and left hand. The sleeves are held in place by a hollow nut on each end, and inside of each nut is a felt washer. The sleeves are slotted their entire length to provide for adjustment and to receive the oil, which feeds through a dust-proof cup on top of the box

Fay & Bowen, Auburn, N. Y., are the manufacturers.

* * *

FRESH FROM THE PRESS.

Dynamometers and the Measurement of Power, by J. J. Flather, Professor of Mechanical Engineering, University of Minnesota. Published by John Wiley & Sons, New York. 394 12mo pages and 115 engravings. Price, $3.00.

This work is a treatise on the construction of dynamometers with a description of their application and also of the apparatus used in connection for the measurement of power. It will be of value to those having to do with the measurement of power whether they be experts or tyros in the business, as the matter is compiled from the author's own extensive experience and also from that of others who have had trustworthy experience with the subject. Considerable reference is made throughout the work to the Flather transmission dynamometer, which instrument is the author's invention, and to the valuable results obtained by its use.

The chapter on the power required to drive machinery and machine tools is peculiarly acceptable at this time when the use of the electric motor is becoming so extensive for isolated driving. The trustworthy information on the subject has generally been in a rather confused state, but in this book there appear a large number of tabulated tests which give opportunity for comparison by which, presumably, safe deductions may be made for shop installations.

Hydraulic Power Engineering, by G. Croyden Marks. Published by D. Van Nostrand & Co., New York. 360 8vo pages and 201 illustrations. Price $3.50.

This important subject appears to have been well handled by the author, as the work contains a wealth of valuable and interesting information. The first chapters are given to principles of hydraulics and the observed flow of water, with notes on the loss of head resulting from the contraction or bends in pipes. While this matter is more or less trite, it is presented in an attractive manner, and is, of course, necessary for proper introduction to the work. The practical matter on packings for sliding surfaces and pipe joints is of value. Lifting machinery receives considerable attention, one part of the work being devoted to platform lifts, workshop and foundry cranes, hydraulic accumulators, etc.